

S. HRG. 113-754

**OVERSIGHT HEARING ON
THE ENVIRONMENTAL PROTECTION AGENCY'S
FISCAL YEAR 2015 BUDGET**

HEARING
BEFORE THE
**COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE**
ONE HUNDRED THIRTEENTH CONGRESS

SECOND SESSION

MARCH 26, 2014

Printed for the use of the Committee on Environment and Public Works



Available via the World Wide Web: <http://www.gpo.gov/fdsys>

**OVERSIGHT HEARING ON THE ENVIRONMENTAL PROTECTION
AGENCY'S FISCAL YEAR 2015 BUDGET**

**OVERSIGHT HEARING ON
THE ENVIRONMENTAL PROTECTION AGENCY'S
FISCAL YEAR 2015 BUDGET**

HEARING
BEFORE THE
**COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS**
UNITED STATES SENATE
ONE HUNDRED THIRTEENTH CONGRESS
SECOND SESSION

—————
MARCH 26, 2014
—————

Printed for the use of the Committee on Environment and Public Works



Available via the World Wide Web: <http://www.gpo.gov/fdsys>

—————
U.S. GOVERNMENT PUBLISHING OFFICE

97-797 PDF

WASHINGTON : 2015

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512-1800; DC area (202) 512-1800
Fax: (202) 512-2104 Mail: Stop IDCC, Washington, DC 20402-0001

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED THIRTEENTH CONGRESS
SECOND SESSION

BARBARA BOXER, California, *Chairman*

THOMAS R. CARPER, Delaware	DAVID VITTER, Louisiana
BENJAMIN L. CARDIN, Maryland	JAMES M. INHOFE, Oklahoma
BERNARD SANDERS, Vermont	JOHN BARRASSO, Wyoming
SHELDON WHITEHOUSE, Rhode Island	JEFF SESSIONS, Alabama
TOM UDALL, New Mexico	MIKE CRAPO, Idaho
JEFF MERKLEY, Oregon	ROGER WICKER, Mississippi
KIRSTEN GILLIBRAND, New York	JOHN BOOZMAN, Arkansas
CORY A. BOOKER, New Jersey	DEB FISCHER, Nebraska
EDWARD J. MARKEY, Massachusetts	

BETTINA POIRIER, *Majority Staff Director*
ZAK BAIG, *Republican Staff Director*

C O N T E N T S

Page

MARCH 26, 2014

OPENING STATEMENTS

Boxer, Hon. Barbara, U.S. Senator from the State of California	1
Vitter, Hon. David, U.S. Senator from the State of Louisiana	20
Whitehouse, Hon. Sheldon, U.S. Senator from the State of Rhode Island	135
Crapo, Hon. Mike, U.S. Senator from the State of Idaho	136
Booker, Hon. Cory A., U.S. Senator from the State of New Jersey	137
Inhofe, Hon. James M., U.S. Senator from the State of Oklahoma	138
Wicker, Hon. Roger, U.S. Senator from the State of Mississippi	140
Sessions, Hon. Jeff, U.S. Senator from the State of Alabama	143
Fischer, Hon. Deb, U.S. Senator from the State of Nebraska, prepared statement	497
Barrasso, Hon. John, U.S. Senator from the State of Wyoming, prepared statement	499
Cardin, Hon. Benjamin L., U.S. Senator from the State of Maryland, prepared statement	577

WITNESS

McCarthy, Hon. Gina, Administrator, U.S. Environmental Protection Agency .	150
Prepared statement	152
Responses to additional questions from:	
Senator Boxer	157
Senator Markey	162
Senator Vitter	164
Senator Wicker	211
Senator Fischer	215

OVERSIGHT HEARING ON THE ENVIRONMENTAL PROTECTION AGENCY'S FISCAL YEAR 2015 BUDGET

WEDNESDAY, MARCH 26, 2014

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee met, pursuant to notice, at 10:01 a.m. in room 406, Dirksen Senate Office Building, Hon. Barbara Boxer (chairman of the committee) presiding.

Present: Senators Boxer, Vitter, Whitehouse, Booker, Inhofe, Barrasso, Sessions, Crapo, Wicker, Boozman, and Fischer.

**OPENING STATEMENT OF HON. BARBARA BOXER,
U.S. SENATOR FROM THE STATE OF CALIFORNIA**

Senator BOXER. The committee will come to order.

We are on a fast track because we have votes. Could I ask members to take their seats, please?

I welcome Administrator McCarthy to this oversight hearing on the 2015 EPA budget.

EPA's mission is to protect the public health and the environment through programs that address clean air, children's health, safe drinking water, toxics, and water quality. Like other Federal agencies, EPA has been asked to do more with less. Five years ago their budget was \$10.3 billion, and the 2015 budget request we are going to discuss today has been reduced to 7.9, a 23 percent cut; and I am particularly concerned about the proposed cuts to the Clean Water and Drinking Water State Revolving Funds and the Diesel Emissions Reduction Grant Program. These programs are critical to protecting our public health.

In addition to funding cuts, EPA has faced other challenges in recent years, including a rogue career employee, John Beale, who has been sentenced to prison for defrauding the American taxpayers. I appreciate the work the Office of Inspector General did to ferret out this employee, and I would like to commend Administrator McCarthy for bringing his outrageous actions to light.

EPA has over 15,000 employees and, just like any organization, public, private, even the military, there are bound to be a few outliers who must be held accountable. But with thousands of dedicated employees, EPA has demonstrated repeated success at improving our families' health by keeping the Nation's air and water clean and safe.

For example, in 2010 alone, the Clean Air Standard and Program under the Clean Air Act prevented 13 million lost work days, prevented more than 160,000 deaths from air pollution, prevented 3.2 million lost school days, prevented 1.7 million asthma attacks.

Administrator McCarthy, I can't find very many agencies that could say that.

I wanted to show a picture of what happens when you don't pay attention to the air. This is another photograph of China. We don't need to have a theory on this; we see what happens when countries don't value their people enough to protect them from dirty air. Actually, there was a new study that shows 3.7 million people worldwide have died prematurely from outdoor air pollution.

We also know, over the last 40 years, while there were people railing against EPA, the economy has grown 212 percent, while air pollution has dropped 68 percent. A responsible budget must not lose sight of our top priorities, including protecting the health and safety of the people.

What is at stake if we do not have adequate safeguards in place? Just look at West, Texas, where 15 people died in a chemical explosion, or look at West Virginia, where a chemical spill contaminated the water supply for 300,000 people. By taking preventive action, we can help communities avoid similar disasters.

I intend, next week, to mark up a bill, the Manchin bill, that he wrote with Senator Rockefeller and myself, the Chemical Safety and Drinking Water Protection Act. I really do pray we can get that done next week here in a bipartisan way. We will get it done, but I am hoping for bipartisanship, because when you have chemicals that are not regulated and they are sitting on top of a drinking water supply, look what happened to that town economically when their drinking water was destroyed. I think we need to act.

I also want to thank EPA for proposing a rule to clarify the jurisdiction of the Clean Water Act. Many colleagues on both sides of the aisle, along with dozens of organizations, including Ducks Unlimited, the Teddy Roosevelt Conservation Partnership, the Farm Bureau, the National Mining Association, the National Association of Homebuilders, have repeatedly called on EPA and the Corps to go through a formal rulemaking to clear up the uncertainty created by two confusing Supreme Court decisions.

This proposed rule will now proceed through an open and transparent process where all views can be heard, including those whose views differ from yesterday's proposal. The proposed rule ensures protections for the wetlands and small streams that can be a source of drinking water for over 117 million Americans. For the first time, EPA has listed bodies of water that are exempted from this regulation, including upland ditches, artificial lakes or ponds, reflecting pools, and swimming pools, and I ask unanimous consent to enter into the record the full list of exemptions. Without objection.

[The referenced documents follow:]

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

6560-50-P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 110.1, 112.2, 116.3, 117.1, 122.2, 230.3, 232.2, 300.5, 300 App. E, 302.3, and 401.11

DEPARTMENT OF DEFENSE

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

33 CFR Part 328.3(a)

[EPA-HQ-OW- 2011-0880; FRL-9901-47-OW]

[RIN 2040- AF30]

Definition of “Waters of the United States” Under the Clean Water Act

AGENCIES: Environmental Protection Agency (EPA); and U.S. Army Corps of Engineers, Department of the Army, Department of Defense.

ACTION: Proposed rule

SUMMARY: The Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) are publishing for public comment a proposed rule defining the scope of waters protected under the Clean Water Act (CWA), in light of the U.S. Supreme Court cases in *U.S. v. Riverside Bayview*, *Rapanos v. United States*, and *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers (SWANCC)*, and *Rapanos v. United States (Rapanos)*.

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

to their effect on the chemical, physical, or biological integrity of a water identified in paragraphs (a)(1) through (3) of this section.

* * * * *

PART 302 – DESIGNATION, REPORTABLE QUANTITIES, AND NOTIFICATION

19. The authority citation for part 302 continues to read as follows:

AUTHORITY: The Clean Water Act, 33 U.S.C. 1251 *et seq.*

20. Section 302.3 is amended by revising the definition of “navigable waters” to read as follows:

§302.3 Definitions

* * * * *

Navigable waters means the waters of the United States, including the territorial seas.

(a) For purposes of all sections of the Clean Water Act, 33 U.S.C. 1251 *et seq.* and its implementing regulations, subject to the exclusions in paragraph (b) of this section, the term “waters of the United States” means:

- (1) All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
- (2) All interstate waters, including interstate wetlands;
- (3) The territorial seas;
- (4) All impoundments of waters identified in paragraphs (a)(1) through (3) and (5) of this section;
- (5) All tributaries of waters identified in paragraphs (a)(1) through (4) of this section;

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

(6) All waters, including wetlands, adjacent to a water identified in paragraphs (a)(1) through (5) of this section; and

(7) On a case-specific basis, other waters, including wetlands, provided that those waters alone, or in combination with other similarly situated waters, including wetlands, located in the same region, have a significant nexus to a water identified in paragraphs (a)(1) through (3) of this section.

(b) The following are not “waters of the United States” notwithstanding whether they meet the terms of paragraphs (a)(1) through (7) of this section —

(1) Waste treatment systems, including treatment ponds or lagoons, designed to meet the requirements of the Clean Water Act.

(2) Prior converted cropland. Notwithstanding the determination of an area’s status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act the final authority regarding Clean Water Act jurisdiction remains with EPA.

(3) Ditches that are excavated wholly in uplands, drain only uplands, and have less than perennial flow.

(4) Ditches that do not contribute flow, either directly or through another water, to a water identified in paragraphs (a)(1) through (4) of this section.

(5) The following features:

(i) artificially irrigated areas that would revert to upland should application of irrigation water to that area cease;

(ii) artificial lakes or ponds created by excavating and/or diking dry land and used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing;

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

(iii) artificial reflecting pools or swimming pools created by excavating and/or diking dry land;

(iv) small ornamental waters created by excavating and/or diking dry land for primarily aesthetic reasons;

(v) water-filled depressions created incidental to construction activity;

(vi) groundwater, including groundwater drained through subsurface drainage systems; and

(vii) gullies and rills and non-wetland swales.

(c) Definitions —

(1) **Adjacent:** The term *adjacent* means bordering, contiguous or neighboring. Waters, including wetlands, separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are “adjacent waters.”

(2) **Neighboring:** The term *neighboring*, for purposes of the term “adjacent” in this section, includes waters located within the riparian area or floodplain of a water identified in paragraphs (a)(1) through (5) of this section, or waters with a shallow subsurface hydrologic connection or confined surface hydrologic connection to such a jurisdictional water.

(3) **Riparian area:** The term *riparian area* means an area bordering a water where surface or subsurface hydrology directly influence the ecological processes and plant and animal community structure in that area. Riparian areas are transitional areas between aquatic and terrestrial ecosystems that influence the exchange of energy and materials between those ecosystems.

(4) **Floodplain:** The term *floodplain* means an area bordering inland or coastal waters that was formed by sediment deposition from such water under present climatic conditions and is

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

inundated during periods of moderate to high water flows.

(5) **Tributary:** The term *tributary* means a water physically characterized by the presence of a bed and banks and ordinary high water mark, as defined at 33 CFR § 328.3(e), which contributes flow, either directly or through another water, to a water identified in paragraphs (a)(1) through (4) of this section. In addition, wetlands, lakes, and ponds are tributaries (even if they lack a bed and banks or ordinary high water mark) if they contribute flow, either directly or through another water to a water identified in paragraphs (a)(1) through (3) of this section. A water that otherwise qualifies as a tributary under this definition does not lose its status as a tributary if, for any length, there are one or more man-made breaks (such as bridges, culverts, pipes, or dams), or one or more natural breaks (such as wetlands at the head of or along the run of a stream, debris piles, boulder fields, or a stream that flows underground) so long as a bed and banks and an ordinary high water mark can be identified upstream of the break. A tributary, including wetlands, can be a natural, man-altered, or man-made water and includes waters such as rivers, streams, lakes, ponds, impoundments, canals, and ditches not excluded in paragraphs (b)(3) or (4) of this section.

(6) **Wetlands:** The term *wetlands* means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

(7) **Significant nexus:** The term *significant nexus* means that a water, including wetlands, either alone or in combination with other similarly situated waters in the region (i.e., the watershed that drains to the nearest water identified in paragraphs (a)(1) through (3) of this section), significantly affects the chemical, physical, or biological integrity of a water identified in

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

paragraphs (a)(1) through (3) of this section. For an effect to be significant, it must be more than speculative or insubstantial. Other waters, including wetlands, are similarly situated when they perform similar functions and are located sufficiently close together or sufficiently close to a “water of the United States” so that they can be evaluated as a single landscape unit with regard to their effect on the chemical, physical, or biological integrity of a water identified in paragraphs (a)(1) through (3) of this section.

PART 401 – GENERAL PROVISIONS

21. The authority citation for part 401 continues to read as follows:

AUTHORITY: The Clean Water Act, 33 U.S.C. 1251 *et seq.*

22. Section 401.11 is amended by revising the definition of “navigable waters” to read as follows:

§401.11 General Definitions

* * * * * (l) The term *navigable waters* means the waters of the United States, including the territorial seas.

(a) For purposes of all sections of the Clean Water Act, 33 U.S.C. 1251 *et seq.* and its implementing regulations, subject to the exclusions in paragraph (b) of this section, the term “waters of the United States” means:

- (1) All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
- (2) All interstate waters, including interstate wetlands;
- (3) The territorial seas;

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

- (4) All impoundments of waters identified in paragraphs (a)(1) through (3) and (5) of this section;
 - (5) All tributaries of waters identified in paragraphs (a)(1) through (4) of this section;
 - (6) All waters, including wetlands, adjacent to a water identified in paragraphs (a)(1) through (5) of this section; and
 - (7) On a case-specific basis, other waters, including wetlands, provided that those waters alone, or in combination with other similarly situated waters, including wetlands, located in the same region, have a significant nexus to a water identified in paragraphs (a)(1) through (3) of this section.
- (b) The following are not “waters of the United States” notwithstanding whether they meet the terms of paragraphs (a)(1) through (7) of this section —
- (1) Waste treatment systems, including treatment ponds or lagoons, designed to meet the requirements of the Clean Water Act.
 - (2) Prior converted cropland. Notwithstanding the determination of an area’s status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act the final authority regarding Clean Water Act jurisdiction remains with EPA.
 - (3) Ditches that are excavated wholly in uplands, drain only uplands, and have less than perennial flow.
 - (4) Ditches that do not contribute flow, either directly or through another water, to a water identified in paragraphs (a)(1) through (4) of this section.
 - (5) The following features:
 - (i) artificially irrigated areas that would revert to upland should application of irrigation water to that area cease;

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

(ii) artificial lakes or ponds created by excavating and/or diking dry land and used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing;

(iii) artificial reflecting pools or swimming pools created by excavating and/or diking dry land;

(iv) small ornamental waters created by excavating and/or diking dry land for primarily aesthetic reasons;

(v) water-filled depressions created incidental to construction activity;

(vi) groundwater, including groundwater drained through subsurface drainage systems; and

(vii) gullies and rills and non-wetland swales.

(c) Definitions —

(1) **Adjacent:** The term *adjacent* means bordering, contiguous or neighboring. Waters, including wetlands, separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are “adjacent waters.”

(2) **Neighboring:** The term *neighboring*, for purposes of the term “adjacent” in this section, includes waters located within the riparian area or floodplain of a water identified in paragraphs (a)(1) through (5) of this section, or waters with a shallow subsurface hydrologic connection or confined surface hydrologic connection to such a jurisdictional water.

(3) **Riparian area:** The term *riparian area* means an area bordering a water where surface or subsurface hydrology directly influence the ecological processes and plant and animal community structure in that area. Riparian areas are transitional areas between aquatic and

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

terrestrial ecosystems that influence the exchange of energy and materials between those ecosystems.

(4) **Floodplain:** The term *floodplain* means an area bordering inland or coastal waters that was formed by sediment deposition from such water under present climatic conditions and is inundated during periods of moderate to high water flows.

(5) **Tributary:** The term *tributary* means a water physically characterized by the presence of a bed and banks and ordinary high water mark, as defined at 33 CFR § 328.3(e), which contributes flow, either directly or through another water, to a water identified in paragraphs (a)(1) through (4) of this section. In addition, wetlands, lakes, and ponds are tributaries (even if they lack a bed and banks or ordinary high water mark) if they contribute flow, either directly or through another water to a water identified in paragraphs (a)(1) through (3) of this section. A water that otherwise qualifies as a tributary under this definition does not lose its status as a tributary if, for any length, there are one or more man-made breaks (such as bridges, culverts, pipes, or dams), or one or more natural breaks (such as wetlands at the head of or along the run of a stream, debris piles, boulder fields, or a stream that flows underground) so long as a bed and banks and an ordinary high water mark can be identified upstream of the break. A tributary, including wetlands, can be a natural, man-altered, or man-made water and includes waters such as rivers, streams, lakes, ponds, impoundments, canals, and ditches not excluded in paragraphs (b)(3) or (4) of this section.

(6) **Wetlands:** The term *wetlands* means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

This document is a prepublication version, signed by the EPA Administrator, Gina McCarthy, on 03/25/2014 and the Assistant Secretary of the Army (Civil Works), Jo Ellen Darcy, on 03/24/2014. We have taken steps to ensure the accuracy of this version, but it is not the official version.

(7) **Significant nexus:** The term *significant nexus* means that a water, including wetlands, either alone or in combination with other similarly situated waters in the region (i.e., the watershed that drains to the nearest water identified in paragraphs (a)(1) through (3) of this section), significantly affects the chemical, physical, or biological integrity of a water identified in paragraphs (a)(1) through (3) of this section. For an effect to be significant, it must be more than speculative or insubstantial. Other waters, including wetlands, are similarly situated when they perform similar functions and are located sufficiently close together or sufficiently close to a “water of the United States” so that they can be evaluated as a single landscape unit with regard to their effect on the chemical, physical, or biological integrity of a water identified in paragraphs (a)(1) through (3) of this section.

* * * * *

Clean Water Act Exclusions and Exemptions Continue for Agriculture

U.S. EPA and the U.S. Army Corps of Engineers have proposed a joint rule to clarify the types of waters that are and are not covered by the Clean Water Act to bring certainty and predictability, including to agriculture. For the past several years, EPA and the Army Corps have listened to important input from the agriculture community. Using the input from those discussions, the agencies then worked with the U.S. Department of Agriculture to ensure that concerns raised by farmers and the agricultural industry were addressed in the proposed rule.

The proposed rule focuses on reducing the confusion and complexity about where the Clean Water Act applies following Supreme Court decisions in 2001 and 2006. The proposed rule is consistent with the more narrow readings of Clean Water Act protection by the Supreme Court. Any normal farming activity that does not result in a point source discharge of pollutants into waters of the U.S. still does not require a permit.

The proposed rule preserves existing Clean Water Act exemptions and exclusions for agricultural activities. In addition, in coordination with USDA's Natural Resource Conservation Service, EPA and the Army Corps will now exempt 53 established NRCS conservation practices implemented in accordance with published standards from Clean Water Act Section 404 dredged or fill permitting requirements if they occur in waters covered by the Clean Water Act.

The proposed rule will:

- Preserve current agricultural exemptions for Clean Water Act permitting, including:
 - Normal farming, silviculture, and ranching practices. Those activities include plowing, seeding, cultivating, minor drainage, and harvesting for production of food, fiber, and forest products.
 - Upland soil and water conservation practices.
 - Agricultural stormwater discharges.
 - Return flows from irrigated agriculture.
 - Construction and maintenance of farm or stock ponds or irrigation ditches on dry land.
 - Maintenance of drainage ditches.
 - Construction or maintenance of farm, forest, and temporary mining roads.
- Provide greater clarity and certainty to farmers.
- Avoid economic burden on agriculture.
- Encourage the use of voluntary conservation practices.
- Be consistent with and support existing USDA programs.

The proposed rule will NOT:

- Cover groundwater
- Cover tiles drains
- Increase regulation of ditches
- Protect any new types of waters
- Affect areas generally previously excluded from jurisdiction, including:
 - Artificially irrigated areas that would revert to upland if irrigation stops.
 - Artificial lakes or ponds created by excavating and/or diking dry land and used for purposes such purposes as rice growing, stock watering or irrigation.
 - Artificial ornamental waters created for primarily aesthetic reasons.
 - Water-filled depressions created as a result of construction activity.
 - Pits excavated in upland for fill, sand, or gravel.
 - Prior converted cropland.
 - Waste treatment systems (including treatment ponds or lagoons).

Improving Opportunities for Conservation Programs

EPA and the Army Corps have worked with USDA to improve opportunities for farmers, ranchers, and foresters to participate in USDA's voluntary conservation programs that help to protect water quality and improve the environment.

During the coordination with USDA, the agencies ensured that 53 specific agriculture conservation practices that help protect or improve water quality will not be subject to Clean Water Act dredged or fill permitting requirements, including habitat restoration and establishing riparian forest buffers. This is being done through an interpretive rule that was published at the same time as the proposed rule and will go into effect immediately.

To qualify for this exemption, the activities must be part of an established farming, forestry, or ranching operation, consistent with the statute and regulations and be implemented in conformance with Natural Resource Conservation Service technical standards.

Farmers and producers will not need a determination of whether the activities are in "waters of the United States" to qualify for this exemption nor will they need site-specific pre-approval from either the Corps or the EPA before implementing these specified agricultural conservation practices to qualify for the exemption.

Through a memorandum of understanding, EPA, the Army Corps, and USDA have set up a process for working together to implement these new exemptions and for periodically identifying, reviewing, and updating NRCS conservation practice standards and activities that would qualify under the exemption.

More information: www.epa.gov/uswaters



**U.S. Environmental Protection Agency and U.S. Department of the Army
Interpretive Rule Regarding the Applicability of
Clean Water Act Section 404(f)(1)(A)**

SUBJECT: Interpretive Rule Regarding Applicability of the Exemption from Permitting under section 404(f)(1)(A) of the Clean Water Act to Certain Agricultural Conservation Practices.

PURPOSE: The purpose of this interpretive rule is to clarify the applicability of the exemption from permitting provided under section 404(f)(1)(A) of the Clean Water Act (CWA) to discharges of dredged or fill material associated with certain agricultural conservation practices based on the Natural Resources Conservation Service (NRCS) conservation practice standards that are designed and implemented to protect and enhance water quality.¹

BACKGROUND:

Section 404(f)(1)(A) of the CWA exempts from permit requirements certain discharges associated with normal farming, silviculture, and ranching activities in waters of the United States, including wetlands. It is important to emphasize that this interpretive rule identifies additional activities considered exempt from permitting under section 404(f)(1)(A), but does not affect, in any manner, the scope of agriculture, silviculture, and ranching activities currently exempt from permitting under section 404(f)(1)(A) including, for example, plowing, seeding, cultivation, minor drainage, etc.

Section 404(f)(1)(A) does not provide an automatic exemption for all discharges related to farming, silvicultural or ranching practices. Rather, Section 404(f)(1) exempts only those discharges associated with activities specifically identified in subparagraphs (A) through (F), and "other activities of essentially the same character as named" (44 FR 34264). Section 404(f)(1)(A) lists discharges of dredged or fill material from "normal farming, silviculture and ranching activities, such as plowing, seeding, cultivating, minor drainage, harvesting for the production of food, fiber, and forest products, or upland soil and water conservation practices." This interpretive rule further clarifies the scope of this statutory exemption.

¹ As this interpretation addresses primarily agricultural-related activities, characterizations of such practices have been developed in consultation with the U.S. Department of Agriculture (USDA).

Section 404(f)(1)(A) is limited to discharges associated with activities listed in the statute and defined by the agencies' regulations and that are part of an "established (i.e., ongoing) farming, silviculture, or ranching operation" (40 CFR 232.3(c)(1)(ii)(A); 33 CFR 323.4(a)(1)(ii)). This "established" requirement reconciles the dual intent reflected in the legislative history that although section 404 should not unnecessarily restrict farming, silviculture, or ranching from continuing at a particular site, discharge activities which could destroy wetlands or other waters should be subject to regulation.²

The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers' (Corps) regulations (40 CFR 230 and 33 CFR 320) and preamble to these regulations provide additional detail on "normal" activities listed in section 404(f)(1)(A). The words "such as" have been consistently interpreted as meaning the section applies "to the activities named in the statute and other activities of essentially the same character as named," and "preclude[s] the extension of the exemption ... to activities that are unlike those named." (44 FR 34264).

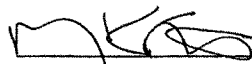
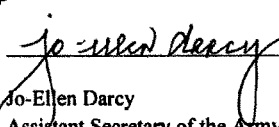
INTERPRETATION FOR CERTAIN CONSERVATION PRACTICES:

USDA and NRCS's natural resources conservation programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. These longstanding USDA programs are effective in promoting the water quality and broader environmental goals identified in both the Food Security Act and Clean Water Act. The agencies believe working together to improve the consistency and integration of programs like these is fully consistent with the law, promotes the mutual objectives of our regulations and statutes, and increases clarity and predictability for the agriculture community. The result is good for the nation's waters and for farmers and foresters who want to protect the resources on their lands.

In light of the longstanding adoption of these agricultural conservation practices and their goal of protecting and enhancing water quality, the section 404(f)(1)(A) exemption is interpreted to cover certain agricultural conservation practices as "normal farming" activities. Normal farming necessarily includes conservation and protection of soil, water and related resources in order to sustain agricultural productivity, along with other benefits to environmental quality and continued economic development. "Upland soil and water conservation practices" are explicitly identified in the statute as "normal" farming activities, and conservation activities within the waters of the U.S. that include discharges in waters of the U.S. and that are designed to protect and enhance the waters of the U.S. have been determined to be of essentially the same character. As the statute does not limit the exemption to only those activities explicitly listed, it is reasonable to conclude that agricultural conservation practices that are associated with waters and where water quality benefits accrue are similar enough to also be exempt from the section 404 permitting requirements. This interpretation preserves congressional intent by ensuring that beneficial agricultural conservation practices will not be unnecessarily restricted so long as those activities are designed and implemented to protect and enhance water quality and do not destroy waters.

² This interpretive rule does not affect section 404(f)(2) of the CWA.

Specific NRCS agricultural conservation practices, identified by the EPA, the Army, and USDA, that could include the discharge of dredged or fill material in a waters of the U.S. for the purposes of benefitting those waters are appropriately considered "normal farming" activities and exempt from permitting under Section 404(f)(1)(A). To qualify for this exemption, the activities must be part of an "established (i.e., ongoing) farming, silviculture, or ranching operation," consistent with the statute and regulations. The activities must also be implemented in conformance with NRCS technical standards. So long as these activities are implemented in conformance with NRCS technical standards, there is no need for a determination of whether the discharges associated with these activities are in "waters of the United States" nor is site-specific pre-approval from either the Corps or the EPA necessary before implementing these specified agricultural conservation practices. The EPA, the Army, and USDA will enter into a Memorandum of Agreement to develop and implement a process for identifying, reviewing and updating NRCS agricultural conservation practices and activities that may include discharges in waters of the United States that would qualify under the exemption established by section 404(f)(1)(A).

	3/25/14		MAR 25 2014
(Date)			(Date)
Nancy K. Stoner		Jo-ellen Darcy	
Acting Assistant Administrator for Water		Assistant Secretary of the Army (Civil Works)	
U.S. Environmental Protection Agency		U.S. Department of the Army	

Corrected March 24, 2014

Details regarding conservation practice standards are available on NRCS' website at
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/neps/?cid=nrcs143_026849.

**NRCS CONSERVATION PRACTICE STANDARDS
 EXEMPT FROM PERMITTING UNDER CLEAN WATER ACT SECTION 404(f)(1)(A)**

Practice #	Practice Name	Creation Date	Notes
314	Brush Management	Sep-09	
315	Herbaceous Weed control	Apr-10	
320	Irrigation Canal or Lateral	Sep-10	
326	Clearing and Snagging	Jul-10	
327	Conservation Cover	Sep-10	
338	Prescribed Burning	Sep-10	
342	Critical Area Planting	Dec-13	
353	Monitoring Well	Sep-10	
380	Windbreak/Shelterbelt Establishment	May-11	
382	Fence	Apr-13	
383	Fuel Break	Apr-05	
386	Field Border	Dec-13	
388	Irrigation Field Ditch	Apr-11	
390	Riparian Herbaceous Cover	Sep-10	
391	Riparian Forest buffer	Jul-10	
393	Filter Strip	Dec-13	
394	Firebreak	Sep-10	
395	Stream Habitat Improvement and Management	Sep-10	
396	Aquatic Organism passage	Apr-11	
398	Fish Raceway or Tank	Sep-09	
399	Fishpond Management	Sep-11	
400	Bivalve Aquaculture Gear and Biofouling Control	Apr-11	
412	Grassed Waterway	Apr-10	activities that convert waters to non-waters are not exempt
422	Hedgerow Planting	Sep-10	
423	Hillside Ditch	May-08	
453	Land Reclamation, Landslide Treatment	Feb-05	
455	Land Reclamation, Toxic Discharge Control	May-05	
460	Land Clearing	Sep-11	
484	Mulching	May-11	
490	Tree/Shrub Site Preparation	Jan-06	
500	Obstruction Removal	Jan-10	
511	Forage Harvest Management	Apr-10	

Corrected March 24, 2014

512	Forage and Biomass Planting	Jan-10
528	Prescribed Grazing	Sep-10
533	Pumping Plant	May-11
543	Land Reclamation, Abandoned Mined land	Aug-06
544	Land Reclamation, Currently Mined Land	Aug-06
548	Grazing Land Mechanical Treatment	Sep-10 chiseling or deep ripping in wetlands is not exempt
550	Range Planting	Apr-10
568	Trails and Walkways	Jan-10
575	Animal Trails and Walkways	Apr-10
578	Stream Crossing	Sep-11
587	Structure for Water Control	Apr-10
601	Vegetative Barrier	Jan-10
612	Tree/Shrub Establishment	May-11
643	Restoration and Management of Rare and Declining Habitats	Sep-10
644	Wetland Wildlife Habitat Management	Sep-10
646	Shallow Water Development and Management	Sep-10
647	Early Successional Habitat Development / Management	Sep-10
650	Windbreak/Shelterbelt Renovation	Jul-10
654	Road/Trail/Landing Closure and Treatment	Nov-08
655	Forest Trails and Landings	Sep-11
657	Wetland Restoration	Sep-10
659	Wetland Enhancement	Sep-10
660	Tree/Shrub Pruning	Jan-06
666	Forest Stand Improvement	May-11

Senator BOXER. EPA has a record that Americans be proud of, and I want to show you the support that EPA has in the public; we have it on a chart here. The American people know what you are doing and they appreciate what you are doing. Sixty-six percent of voters favor EPA updating air pollution standards by setting stricter limits. Seventy-two percent of voters support new standards for carbon pollution from power plants.

So, Madam Administrator, I have to stop. I am holding myself to 5 minutes. I will hold everyone to that. Thank you for being here.

With that, I would call on our ranking member, Senator Vitter.

**OPENING STATEMENT OF HON. DAVID VITTER,
U.S. SENATOR FROM THE STATE OF LOUISIANA**

Senator VITTER. Thank you, Madam Chair. Thank you all for being with us.

This is a very important oversight hearing about EPA's budget and overall what is going on at EPA, its management practices, how it is being run. This committee obviously has that fundamental oversight responsibility. The starkest example of concerns about how EPA is being run, what I would characterize as a long-term culture at EPA, is the case of the former senior EPA official, John Beale. Of course, he has turned out to be a manipulator and charlatan of renowned proportions.

We now know that EPA dithered for years rather than take action against a fake CIA agent who stole over \$1 million of taxpayer money. This and other failings are detailed in a series of memoranda issued by my committee staff, which I would like to enter into the record at this time.

Senator BOXER. Without objection, so ordered.
[The referenced documents follows:]

BARBARA BOXER, CALIFORNIA, CHAIRMAN
 MAX BAILEY, MONTANA
 THOMAS H. CARPER, DELAWARE
 BENJAMIN L. CARDIN, MARYLAND
 BISHOPRE SANDERS, VERMONT
 SHELLEY MURPHY LEWIS, RHODE ISLAND
 TUDOR GALL, NEW MEXICO
 JEFF MERKLEY, OREGON
 KRISTEN GILLIBRAND, NEW YORK
 CORY A. BOOKER, NEW JERSEY

DAVID VITTER, LOUISIANA
 JAMES M. INHOFE, OKLAHOMA
 JOHN KARRASCO, WYOMING
 JEFF SESSIONS, ALABAMA
 MIKE CRAPO, IDAHO
 ROGER WOODEN, MISSISSIPPI
 JOHN BOGDMAN, ARKANSAS
 DEB FISCHER, NEBRASKA

United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
 WASHINGTON, DC 20510-6175

SEITZAN PUMBER, MAJORITY STAFF DIRECTOR
 ZAK BARR, REPUBLICAN STAFF DIRECTOR

MEMORANDUM

TO: Republican Members of the Senate EPW Committee
FROM: Republican Committee Staff
DATE: February 4, 2014
RE: Additional Questions Regarding EPA Negligence in Responding to Beale Fraud

John Beale, a long-time member of the Environmental Protection Agency's (EPA) senior staff, perpetrated fraud against the Agency and against American taxpayers from at least 2000 through his voluntary retirement in 2013, masquerading as a CIA agent in order to take advantage of the Agency's lax internal controls. As the EPA Office of Inspector General (OIG) noted in its Early Warning Report, issued pursuant to U.S. Senate Environment and Public Works Committee Ranking Member David Vitter's (R-La.) request, EPA management did not take timely effective action to address Beale's erroneous retention bonuses and pay in excess of statutory limits.¹ However, "lack of timely effective action" is a generalized statement that fails to adequately reflect actual events surrounding those responsible for managing Beale. In an effort to further inform the public on how Beale got away with his fraud for so long, EPW Republicans have conducted an exhaustive review of materials obtained through its own investigatory efforts to untangle the web of unaccountability that permeated the Agency. This focuses on Beale's most recent manager, Gina McCarthy, to articulate what she knew, when she knew it, and what she did with the information when it became available to her.

Managing John Beale

McCarthy's contact with John Beale began when she assumed management of the Office of Air and Radiation (OAR) in June 2009. Shortly after her confirmation as the Assistant Administrator for OAR, she met Beale for a lunch to discuss his work at the Agency, at which point he represented that he also worked for the CIA.² During her recent interview with the OIG, McCarthy represented that she had concerns about Beale since the moment he was hired; however, it is not clear from the available facts that she ever acted on her initial concerns.

Despite her stated "concerns," documents and correspondence show that McCarthy took his word at face value and worked closely with Beale, letting him into her inner circle and consulting frequently with him. In the beginning of her term, McCarthy had three Deputy Assistant Administrators, including Beale, and roughly thirty staff in her immediate office. According to calendar appointments, between June 2009 and June 2010, McCarthy and Beale

¹ EPA Inspector General Early Warning Report at 14

² Beale Dep. 18:15-18:12 Dec. 19, 2013.

had periodic one-on-one meetings.³ In December 2010, McCarthy sent a note to OAR staff announcing that Beale would be resuming his role as the immediate office's lead for all of OAR's international work, and added that she was "very excited to finally get the opportunity to work closely with him."⁴

Beale continued to take days off for CIA work during this period of time,⁵ during which McCarthy received emails from Beale, like the following in May 2010, "Contrary to what I believed when we spoke last Thursday, I do have to travel out of the country next week. Events last week have made this trip necessary."⁶ In December 2010, Beale sent an email referring to events in Pakistan keeping him away from his responsibilities at EPA.⁷ Throughout this time, evidence suggests that McCarthy did not take any steps to confirm whether Beale was indeed an undercover spy working at the EPA.

Failing to Take Action

EPA staff, including those in OAR as well as the Office of Administration and Resource Management (OARM), began to uncover problems related to Beale's pay in mid-2010.⁸ In an interview with the OIG, McCarthy represented that she was not aware of recommendations made by OAR and OARM staff on how to resolve the retention bonus and statutory pay issues concerning Beale. However, there is a significant body of evidence that suggests she was aware, or had been informed by her staff, but that she declined to take action.

For example, by December 15, 2010, an OAR official was already discussing ways to terminate Beale's bonus:

³ E-mail meeting request from Teri Porterfield, Env'tl. Prot. Agency, to John Beale, Senior Policy Advisor, Env'tl. Prot. Agency; e-mail meeting reschedule notification from Shela Poke-Williams, Env'tl. Prot. Agency, to John Beale, Senior Policy Advisor, Env'tl. Prot. Agency; e-mail Meeting Notification from Cindy Huang, Env'tl. Prot. Agency, to John Beale, Senior Policy Advisor, Env'tl. Prot. Agency; e-mail meeting reschedule notification from Teri Porterfield, Env'tl. Prot. Agency, to John Beale, Senior Policy Advisor, Env'tl. Prot. Agency; e-mail meeting request from Teri Porterfield, Env'tl. Prot. Agency to John Beale, Senior Policy Advisor, Env'tl. Prot. Agency. E-mail from Gina McCarthy, Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency, to Office of Air and Radiation, Env'tl. Prot. Agency (Dec. 3, 2010 07:44 AM EST).

⁴ E-mail from Gina McCarthy, Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency, to Office of Air and Radiation, Env'tl. Prot. Agency (Dec. 3, 2010 07:44 AM EST).

⁵ Beale's electronic calendar entries reflect a total 9 days off for "D.O. Oversight" from Jan. 2009 to May 2011.

⁶ E-mail from John Beale, Senior Policy Advisor, Office of Air and Radiation, Env'tl. Prot. Agency, to Gina McCarthy, Assit. Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency (May 8, 2010 07:19 AM EST).

⁷ E-mail from John Beale, Senior Policy Advisor, Office of Air and Radiation, Env'tl. Prot. Agency, to Gina McCarthy, Assit. Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency (Dec. 18, 2010, 02:26 PM EST).

⁸ Office of Inspector Gen., Env'tl. Prot. Agency, Report No. 14-P-0036, Early Warning Report: Internal Controls and Management Actions Concerning John C. Beale Pay Issues, 19 (Dec. 11, 2013).

"I'm writing to ask not about the corrections but about 2011. Specifically, I would like to intervene with the AA now to prevent the bonus from taking effect in 2011. I do not expect the AA to support continuation and in any event the employee has not produced any bona fide offer that I'm aware of."⁹

Later that month, the OAR official issued a memo, which instructed that unless Beale met criteria for a retention bonus, it should be stopped for 2011.¹⁰ On January 12, 2011, the official sent McCarthy a memo informing her that Beale's salary exceeds the statutory threshold and that he and the Office of General Counsel recommended she cancel Beale's bonus.¹¹ Documents obtained by EPW Republicans show that at that time, the OAR official also prepared a draft letter under McCarthy's name requesting information to stop the bonuses. Despite these recommendations, McCarthy did not follow through with any actions to stop the bonus payments for 2011. In fact, EPW Republicans learned that McCarthy was "reluctant to finalize [cancellation of Beale's bonuses] unless OARM [Assistant Administrator] Craig [Hooks] gives her the okay that the White House is aware and there will not be any political fallout."¹² Moreover, it remains unclear whether McCarthy or someone else at EPA took an affirmative action to reauthorize the bonus for 2011, as Agency protocols normally require certification that the circumstances necessitating the bonus still existed.

According to the OIG, McCarthy deferred to OARM on how to handle the situation, but according to McCarthy she "was advised to stand down on the matter since it was a criminal matter and that [OARM] would refer it to the IG." Documents and correspondence show that EPA staff viewed the Beale pay situation as a human resources matter and never as a criminal matter, and Hooks has denied ever characterizing the matter as a criminal one. These conflicting statements do not explain why McCarthy would have made such a representation to the OIG that is inconsistent with what was perceived by her coworkers at the time. This hands-off attitude is also reflected in her response to an OAR official asking, "Has Craig [Hooks at OARM] gotten back to you about the pay issue yet? I'm eager to move ahead with canceling the bonus." McCarthy replied, "No he hasn't. It's now in his hands as far as I am concerned."¹³

In addition to the questions regarding Beale's pay, it appears that at the same time McCarthy put Beale in charge of OAR's international portfolio, she was also on notice that Beale's claim to be a CIA operative was highly questionable. According to an OIG interview

⁹ Email from Scott Monroe, Dir. of Human Res., Office of Air and Radiation, Env'tl. Prot. Agency, to Susan Smith, Office of Admin. and Res. Mgmt, Env'tl. Prot. Agency (Dec. 15, 2010, 11:58 AM EST).

¹⁰ Memorandum from Scott Monroe, Office of Human Res., Office of Air and Radiation, Env'tl. Prot. Agency (Dec. 20, 2010).

¹¹ Memorandum from Scott Monroe, Office of Human Res., Env'tl. Prot. Agency, to Gina McCarthy, Assistant Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency (Jan. 12, 2011).

¹² E-mail from Susan Smith, Env'tl. Prot. Agency, to Karen Higginbotham, Env'tl. Prot. Agency (Feb. 1, 2013 01:09 PM).

¹³ E-mail from Gina McCarthy, Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency, to Scott Monroe, Dir. of Human Res., Office of Air and Radiation, Env'tl. Prot. Agency (Jan. 27, 2011 08:24PM EST).

with Deputy Administrator Bob Perciasepe, McCarthy and Hooks approached him in early 2011 and asked whether Beale worked for the CIA. Documents obtained by EPW Republicans show that Perciasepe informed them at that time that EPA had no CIA employees – almost two years before anyone at EPA took steps to verify his claim.

Beale's Lingering Retirement

On May 4, 2011, McCarthy approved a draft email to be sent to all OAR staff announcing Beale's imminent retirement from the Agency:

I'd like to express my appreciation to JB for managing OAR's international efforts these past months while we worked through an important period of leadership transition. ... John will now turn his attention to a few projects where his expertise and experience can continue to add significant value. As you know - John has been a vital part of EPA and the OAR leadership for more years than he cares to remember. He is beginning to look forward to his retirement in the near future - but thankfully has agreed to work on some key efforts in the near term.¹⁴

This arrangement, with an indefinite termination date, allowed Beale enough ambiguity to continue his fraud. According to Beale's sentencing memorandum, beginning in June 2011, and for the next 18 months, "the scale of his fraud and deception became even more egregious."¹⁵ On September 22, 2011, McCarthy and others attended his retirement party. However, he never officially retired and instead continued to report his time to his assistant, was paid his salary plus bonus, and continued to use his EPA blackberry.

On March 29, 2012, an OAR official raised concerns about Beale's expanded fraud when he asked McCarthy about the status of Beale's retirement. McCarthy responded that she "thought he had retired,"¹⁶ then turned to OARM to take action.¹⁷ Despite being aware of the fact in March 2012 that one of her employees was collecting his paycheck without providing any work product, this arrangement continued for seven more months before McCarthy contacted Beale in November 2012.

Around this same time frame, according to documents obtained by EPW Republicans, officials at EPA began to investigate whether Beale was actually an undercover CIA agent. On

¹⁴ E-mail from Gina McCarthy, Assistant Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency, to John Beale, Deputy Assist. Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency (May 04, 2011 12:00 EST).

¹⁵ Sentencing Memorandum of John C. Beale, *United States v. John C. Beale*, Cr. No. 13-247 ESH (D. D.C. Filed Dec. 9, 2013).

¹⁶ E-mail from Scott Monroe, Env'tl. Prot. Agency to Gina McCarthy, Assist. Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency, (Mar. 29, 2012 09:59 AM EST); E-mail from Gina McCarthy, Assist. Adm'r, Office of Air and Radiation, Env'tl. Prot. Agency, to Scott Monroe, Env'tl. Prot. Agency (Mar. 29, 2012 05:48 PM EST).

¹⁷ E-mail from Gina McCarthy, Assist. Adm'r Office of Air and Radiation, Env'tl. Prot. Agency to Craig Hooks, (Apr. 02, 2012 10:53 AM EST).

December 12, 2012, McCarthy was informed by staff at EPA's Office of Homeland Security that it was highly unlikely that Beale was a CIA agent, even though Perciasepe had already told her the same thing. With the knowledge that Beale is likely not CIA and had been collecting a paycheck for over a year while performing no EPA-related work, McCarthy met with Beale, over a year after attending his retirement party, who informed her that because the real estate market tanked, he was no longer planning on retiring.¹⁸ Two more months passed before McCarthy on February 5, 2013, informed Beale that she will be cancelling his retention bonus as she had "found no documentation from you or elsewhere that would support reauthorization" – information she had been aware of for nearly two years. Even after this series of events, the OIG did not receive notice of concerns with Beale until February 11, 2013.¹⁹ On April 30, 2013, McCarthy allowed Beale to voluntarily retire with full benefits.

Troubling Inconsistencies

When asked, "In your opinion, is it possible that this fraud could have gone undiscovered if it were not for Administrator McCarthy's actions?" Patrick Sullivan with the OIG testified that, "I think it's highly likely that had not been Ms. McCarthy raising the alarm, this never would have been discovered."²⁰

Sullivan's statement ignores the work performed by OARM and OAR officials who spent months pressing McCarthy to take action on Beale's undeserved bonus income. Moreover, the OIG glosses over the fact that Beale did not show up for work at the EPA for six months, while continuing to receive full pay and benefits, before OAR officials alerted McCarthy to the fact. It took another eight months before EPA began to inquire the veracity of Beale's status as a CIA operative.

The testimony of Perciasepe has also misled the characterization of McCarthy's role. When asked to explain the delay for reporting Beale to the OIG, Perciasepe responded:

"When the- when Assistant Administrator McCarthy who I want to point out once again, no one ever questioned this for over a decade. This question is, the first thing she wanted to do and the first thing she wanted to see was whether or not this person had any of these relationships that-that are being discussed or she asked in the General Counsel and the Office of Resource Management where our personnel-our folks are, they asked the Office of Homeland Security who has relationships with the intelligence community. And when nothing could be found

¹⁸ Early Warning Report, *supra*, note 1.

¹⁹ Elkins testimony before OGR, p. 5. *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. (2013) (Testimony of Arthur A. Elkins Jr., Inspector General, EIntl. Prot. Agency).

²⁰ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. (2013) (Testimony of Patrick Sullivan, Assist. Inspector General for Investigations, EIntl. Prot. Agency).

there, I think it was quickly-and confirmed then quickly as Mr. Sullivan just mentioned, it was quickly referred to the Inspector General.”²¹

Much of the confusion stems from the EPA OIG’s focus on Beale’s status as a CIA agent and when officials were first suspicious of his cover story, which allowed him to perpetrate his massive fraud. But the fact remains, Beale was tried and convicted for stealing time and money from the Agency, not for impersonating an undercover CIA operative.²² His actions were fraudulent, regardless of the circumstances surrounding his CIA status. These actions were known within EPA as early as 2010, but senior officials, including McCarthy, did not take action until the problem grew so large it could no longer be ignored.

²¹ *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. (2013) (Testimony of Hon. Bob Perciasepe, Deputy Adm’r, Env’tl. Prot. Agency).

²² Statement of the Offense, *United States v. John C. Beale*, Cr. No. 13-247 ESH (D. D.C. Signed Sept. 27 2013).

BARBARA BOHRER, CALIFORNIA, CHAIRMAN
 MAX BAILEY, MONTANA
 THOMAS R. CARPER, DELAWARE
 BENJAMIN L. CARDIN, MARYLAND
 BENHART RANDOLPH, VERMONT
 SUFLOON WOOTEN/PERCE, RHODE ISLAND
 TOM UDALL, NEW MEXICO
 JEFF MERKLEY, OREGON
 KRISTEN GILLIBRAND, NEW YORK
 GARY A. RUDNICK, NEW JERSEY
 DAVID VITTER, LOUISIANA
 JAMES M. INHOFE, OKLAHOMA
 JOHN BARRASSO, WYOMING
 RICH BLESSING, ALABAMA
 MIKE CRANG, IDAHO
 ROBERT WICKER, MISSISSIPPI
 JOHN BOOZMAN, ARKANSAS
 ERIC HITCHER, NEBRASKA

United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

WASHINGTON, DC 20510-6175

BETINA POWERS, MANAGER, STAFF DIRECTOR
 PAK BASH, RESEARCH STAFF DIRECTOR

MEMORANDUM

TO: Republican Members of the Senate EPW Committee
 FROM: Republican Committee Staff
 DATE: February 5, 2014
 RE: Additional Questions Relating EPA Negligence in Responding to Beale Fraud (Perciasepe)

Background

On February 4, 2014, the Committee on Environment and Public Works (EPW) Republicans issued a memorandum sharing previously undisclosed information about Environmental Protection Agency (EPA) Administrator Gina McCarthy's response to questions raised internally about former senior EPA official, John Beale, a felon convicted of stealing upwards of a million dollars from the Agency. The memorandum highlighted the fact that McCarthy was slow to react to reports that Beale was being paid a 25% bonus without appropriate documentation and certifications, warnings that his pay was in excess of the statutory threshold, and information that seriously called into question Beale's claims to be an undercover CIA agent. The purpose of this memorandum is to share additional information EPW Republicans have obtained regarding EPA Deputy Administrator Bob Perciasepe's role in the Beale saga.

Perciasepe's Relationship with Beale

It appears that Bob Perciasepe first developed a relationship with Beale during his tenure at EPA under the Clinton Administration. In 1998, President Clinton appointed Perciasepe to serve as the Assistant Administrator (AA) for the Office of Air and Radiation (OAR), at which point he worked with and supervised John Beale. According to documents obtained by EPW Republicans, Beale's long-term personal assistant recalled that then-AA Perciasepe often had closed-door meetings with Beale.¹ During a recent Congressional hearing after Beale's fraud was exposed, "It's painful for me to go through this. But this was a person who had a reputation-a positive reputation in the federal government, both inside EPA and outside EPA in that time period."²

¹ Memorandum of interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, interview with Addie Johnson 3 (Apr. 10, 2013).

² *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 73 (2013) (Testimony of Hon. Bob Perciasepe, Deputy Adm'r, Env'tl. Prot. Agency).

As Beale's supervisor, Perciasepe provided the final approval for the reauthorization of Beale's Retention Incentive Bonus in June 2000.³ According to the EPA Office of Inspector General (OIG), this bonus provided Beale an annual 25% raise that should have expired in 2003, but continued uninterrupted until 2013, accruing nearly \$500,000 in excess pay to Beale.⁴ In August 2000, Perciasepe also approved Beale's promotion to Senior Leader (SL), a position equivalent to Senior Executive Service that exponentially increased Beale's salary. According to Beale, Perciasepe was an advocate for the promotion, "In the '98 – '99 time period there were discussions about a promotion for me, and Bob Perciasepe and then Administrator Carol Browner, and we had a number of discussions and go-arounds about that."⁵ Once Beale was appointed to SL, he held an equivalent title as his colleague and close friend Robert Brenner, Deputy Assistant Administrator, and Perciasepe became his direct supervisor.⁶

Problems with the Retention Bonus

As the OIG has reported, Beale received improper payments as a result of the bonus Perciasepe authorized in 2000.⁷ According to Perciasepe, the problem with the bonus was the failure to stop the bonuses, not with his original authorization:

One was based on the original one and one was based on the one that I did. Those are legitimate years that he could have gotten a retention bonus under the rules of the agency. The problem we have is it was nothing that stopped it. It just kept going.⁸ (emphasis added)

Perciasepe reiterated this point later:

The problem is not in the original rationale for that back in the '90s. The problem is that it kept getting re-certified without any re-certification process. So it went on through the time period that, I think, the Inspector General was talking about, so the issue was that when he was at work and not at work or not during the initial granting of the retention.⁹

However, evidence has emerged that suggests there were serious flaws with the bonus Perciasepe authorized in 2000. According to the OIG, "A written offer is not required although most packages do have a written offer attached. What is required, the supervisor recommending the

³ Memorandum from Bob Perciasepe, Assist. Adm'r, Office of Air & Radiation to Romulo Diaz, Assist. Adm'r, Office of Admin. & Res. Mgmt. 1-2 (June 22, 2000).

⁴ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 2 (2013) (Written Testimony of Patrick Sullivan, Assist. Inspector Gen. for Investigations, Evtl. Prot. Agency).

⁵ Beale Dep.39:20-40:1 Dec. 19, 2013.

⁶ Beale Dep.59:1-59:5.

⁷ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 2 (2013) (Written Testimony of Patrick Sullivan, Assist. Inspector Gen. for Investigations, Evtl. Prot. Agency).

⁸ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 74 (2013) (Testimony of Hon. Bob Perciasepe, Deputy Adm'r, Evtl. Prot. Agency).

⁹ *Id.* at 51.

incentive bonus has to assert that he or she did due diligence to confirm there was an offer.”¹⁰ In the case of Beale’s bonus application in 2000, Perciasepe’s due diligence should have included taking steps to confirm – in writing – that Beale had in fact received an outside offer of employment. Yet, the OIG has confirmed that no such documentation exists and Beale conceded he had not received any written offer of employment to support the bonus in 2000.¹¹

Also, Beale’s deposition raises important questions about and Perciasepe’s due diligence in approving the 2000 bonus. Under oath, Beale stated that he could not recall anyone at the EPA asking him for either a phone number or a written letter to confirm that he in fact had a tangible offer.¹² Beale elaborated:

A: My recollection is that all the other offers were verbal, and although I kind of listened to them initially, they never got to the seriousness where I would have had to talk to the ethics folks about it.

Q: And no one ever asked for proof of an outside offer. It was just generally known; is that correct?

A: To the best of my recollection, that’s correct. I can’t say for sure, but that’s my recollection.¹³ (emphasis added)

Accordingly, there are serious unresolved questions regarding the due diligence that Perciasepe performed prior to authorizing Beale’s 2000 retention bonus.

In addition to a lack of due diligence, it appears there is a material falsehood contained within the application itself. By signing the document, both Perciasepe and Robert Brenner affirmed that Beale had not received previous bonuses, in response to question 10e.¹⁴ Brenner, having been the previous requestor of Beale’s 1991 bonus knew this statement was untrue, but Perciasepe has maintained that he “had no knowledge of any previous [bonus] at this particular moment.”¹⁵ The penalty for forging or falsifying official government records or documents carries ranges from written reprimand to removal.¹⁶ While evidence suggests that a document was falsified knowingly, no one at EPA has been held accountable.

In addition to the problems identified with the 2000 bonus, it looks as if Perciasepe was also a barrier to resolving questions that arose in 2010, when EPA administrative staff discovered that Beale was continuing to receive a 25% bonus, without appropriate certifications.

¹⁰ *Id.* at 69 (Testimony of Patrick Sullivan, Assist. Inspector Gen. for Investigations, Env’tl. Prot. Agency).

¹¹ Beale Dep. 38:12-38:15.

¹² Beale Dep. 38:3-39:3.

¹³ Beale Dep. 38:12-38:15, 38:21-39:3.

¹⁴ Memorandum from Bob Perciasepe, Assist. Adm’r, Office of Air & Radiation to Romulo Diaz, Assist. Adm’r, Office of Admin. & Res. Mgmt. 1-2 (June 22, 2000).

¹⁵ *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 73 (2013) (Testimony of Hon. Bob Perciasepe, Deputy Adm’r, Env’tl. Prot. Agency).

¹⁶ Internal Memorandum, Env’tl. Prot. Agency, *EPA Conduct and Discipline Manual* 17.

In a memorandum released on February 4, 2014,¹⁷ EPW staff revealed that McCarthy failed to take action with regard to Beale's bonus in large part because she had deferred that responsibility to the Office of Administration and Resource Management (OARM).¹⁸ The Committee has also obtained documents which demonstrate that part of the obstacle to OARM resolving the bonus issue was in fact Perciasepe. An email to an OARM official on December 15, 2010, further illustrates this point:

RE: the OAR employee we've discussed who is receiving the retention bonus, I understand that you may not yet have all the information needed to address past overpayments. I'm writing to ask not about the corrections but about 2011. Specifically, I would like to intervene with the AA now to prevent the bonus from taking effect in 2011. I do not expect the AA to support continuation and in any event the employee has not produced any bona fide offer that I'm aware of. I have not spoken to the AA about this. What do I need to do to stop the bonus?¹⁹ (emphasis added)

To which the OARM official replied on February 2, 2011:

I checked with Karen Higginbotham, ERD Director, and she said that Craig Hooks asked to meet with Kim Lewis, OHR Director, on this matter and Karen provided Kim with info from my briefing document. Since Bob P. signed the last retention bonus memo, it is Karen's understanding that Craig was going to speak with him about this employee before advising OAR.²⁰ (emphasis added)

This email was followed by a note in an OAR official's memorandum dated February 9, 2011, stating, "I'm waiting for OARM to tell me it's OK for Gina to sign the memo to end the incentive."²¹ These emails reveal that EPA staff wanted to clear the matter with Perciasepe first before advising McCarthy to take corrective action.

Perciasepe Inconsistencies on CIA story

Conflicting evidence has also emerged regarding when Perciasepe learned about Beale's CIA cover story. This is particularly relevant because it contradicts the timeline of when McCarthy reported her suspicions of Beale to the OIG, supposedly as soon as she was aware that there was a problem.²² According to OIG, "The first executive that ever questioned him working

¹⁷ Memorandum from Republican Members of S. Envt. & Pub. Works Comm. to Republican Comm. Staff, on Facts Regarding Beale Fraud (Feb. 4, 2014).

¹⁸ *Id.*

¹⁹ E-mail from Scott Monroe, Dir. Human Res. Office of Air and Radiation, Envtl. Prot. Agency to Susan Smith, Envtl. Prot. Agency (Dec. 15, 2010 11:58 AM).

²⁰ E-mail from Susan Smith, Envtl. Prot. Agency, to Scott Monroe, Dir. Human Res. Office of Air & Radiation, Envtl. Prot. Agency (Feb. 1, 2011 01:50 PM).

²¹ Notes of Bill Spinazzola, Office of Inspector Gen., Envtl. Prot. Agency, on Interview with Scott Monroe, (Nov. 12, 2013).

²² The IG states that McCarthy notified the OIG on February 11, 2013; *See Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform, 113th Cong. S (2013)* (Written Testimony of Hon. Arthur A. Elkins, Jr., Inspector Gen., Envtl. Prot. Agency) (discussing the timeline for when McCarthy notified the OIG).

for the CIA was in fact Gina McCarthy. Beyond her suspicions, everyone else we interviewed flat-out believed he worked for the CIA.²³ Perciasepe echoed this narrative, stating that he first heard about Beale's claim to be a CIA agent in mid-2012 – around the same time McCarthy first became suspicious.²⁴

Meadows: Thank you, Mr. Chairman. Mr. Perciasepe, I'm intrigued by your testimony because you said earlier that Mr. Beale never represented to you that he worked for the CIA. So is that to follow up that you were-you never heard of him working for the CIA? Because there's a difference. Right, when this unfolded.

Perciasepe: Right, when this unfolded.

Meadows: Before it unfolded. Had you ever heard of that because-so no one ever shared what he was doing?

Perciasepe: No, I didn't see Mr. Beale for 13 years. I don't know what went on from 2001 to -- 2000 till I came back to the agency.²⁵

However, when Perciasepe was interviewed by EPA OIG, he informed investigators that he first became aware of problems with Beale in 2011, when McCarthy and Craig Hooks at OARM came to him asking whether Beale worked for the CIA.²⁶ At that time, Perciasepe informed both of them that "there are no CIA employees working for EPA, so it was important to find out."²⁷ Additionally, Perciasepe viewed Beale's status as a CIA operative as a Human Resources or Personnel matter, and treated it as such. This decision allowed Beale to increase the scale of his fraud in the years to come.

Conclusion

As the Deputy Administrator, and then the Acting Administrator at EPA during the height of Beale's fraud, Perciasepe was in the unique position to shine a light on Beale's activities and to act on the concerns that were brought to his attention. However, instead of demonstrating leadership, he has publicly shared a confusing narrative of what he knew and when he knew it, while simultaneously characterizing McCarthy as a hero for finally questioning Beale's outrageous claims. Most recently, he extolled her role in a memorandum to EPA staff:

By now you are most likely aware that the end of this episode was brought about by the alertness and diligence of current Administrator McCarthy -- in her former role as

²³ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 45 (2013) (Testimony of Patrick Sullivan, Assist. Inspector Gen. for Investigations).

²⁴ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 45 (2013) (Testimony of Hon. Bob Perciasepe, Deputy Adm'r, Evtl. Prot. Agency).

²⁵ *Id.*

²⁶ Notes of Robert Adachi, Office of Inspector Gen., Evtl. Prot. Agency, on Interview with Bob Perciasepe 3 (Nov. 18, 2013).

²⁷ *Id.*

Assistant Administrator for the Office of Air and Radiation -- and the careful work of many professional staff and investigators.²⁸

The evidence presented in this memorandum questions Perciasepe's leadership and management competence at EPA, as shown through his years of deflecting responsibility and failing to be alert and diligent as Beale's supervisor, even when the cracks in Beale's story became clearly evident.

²⁸ E-mail from Bob Perciasepe, Assist. Adm'r, Env'tl. Prot. Agency, to Bob Perciasepe, Assist. Adm'r, Env'tl. Prot. Agency (Dec. 20, 2013 4:28 PM).

SARRAH BOXER, CALIFORNIA, CHAIRMAN
 MAX BAUCUS, MONTANA
 THOMAS R. CARPER, DELAWARE
 BENJAMIN L. CARDIN, MARYLAND
 FRANK R. LUTER, VERMONT
 SHARON WHITEHOUSE, RHODE ISLAND
 TONY DALL, NEW MEXICO
 JEFF MERKLEY, OREGON
 KRISTEN GILLIBRAND, NEW YORK
 CORY A. BOOKER, NEW JERSEY
 DAVID VITTER, LOUISIANA
 JAMES M. INHOFE, OKLAHOMA
 JOHN BARRASSO, WYOMING
 JEFF SESSIONS, ALABAMA
 MIKE CRAPPO, UTAH
 ROGER WICKER, MISSISSIPPI
 JOHN BOOZEMAN, ARKANSAS
 DEB FISCHER, NEBRASKA

United States Senate
 COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
 WASHINGTON, DC 20510-6175

HETTERA FISHER, MAJORITY STAFF DIRECTOR
 TARA SAND, REPUBLICAN STAFF DIRECTOR

MEMORANDUM

TO: Republican Members of the Senate EPW Committee
FROM: Republican Committee Staff
DATE: February 6, 2014
RE: Additional Facts Regarding EPA Negligence in Responding to Beale Fraud (Robert Brenner)

Background

On February 4, 2014, the Committee on Environment and Public Works (EPW) Republican Staff issued a memorandum sharing previously undisclosed information about Environmental Protection Agency (EPA) Administrator Gina McCarthy's response to questions raised internally about former senior EPA official, John Beale, a felon convicted of stealing upwards of a million dollars from the Agency. The memorandum highlighted that McCarthy was slow to react to reports that Beale was being paid an annual 25% bonus without appropriate documentation and certifications; warnings that his pay was in excess of the statutory threshold; and information that seriously called into question Beale's claims to be an undercover CIA agent.¹ On February 5, 2014, EPW Republican staff issued a second memorandum highlighting inconsistencies in the public record with regard to what Deputy Administrator Bob Perciasepe knew and how he responded to information regarding Beale.² This memorandum will focus on additional information the Committee has obtained regarding the role former Deputy Assistant Administrator Robert Brenner played in the Beale fraud, which suggests that Beale could not have accomplished the magnitude of his fraud without the assistance, either knowing or unknowing, of his best friend Brenner.

¹ Memorandum from Republican Staff, S. Comm. on Env't & Pub. Works, to Republican Members, S. Comm. on Env't & Pub. Works, Additional Facts Regarding EPA Negligence in Responding to Beale Fraud (Gina McCarthy) (Feb. 4, 2014).

² Memorandum from Republican Staff, S. Comm. on Env't & Pub. Works, to Republican Members, S. Comm. on Env't & Pub. Works, Additional Facts Regarding EPA Negligence in Responding to Beale Fraud (Bob Perciasepe) (Feb. 5, 2014).

Beale's "Best Friend" Robert Brenner

When the opportunity arose to help develop the new Clean Air Act, I was able to convince my best friend from those days, John Beale M.P.A. '77 to join me in the effort - Robert Brenner³

Everyone in life has a best friend. For nearly four decades, Robert Brenner and John Beale have — in their own words — been “best friends.”⁴ Beale and Brenner met and became friends as classmates in graduate school at Princeton University’s Woodrow Wilson School of Public and International Affairs in 1975.⁵ In 1977, they both graduated with Master’s Degrees in Public Affairs,⁶ but remained very close even as Brenner stayed employed with Princeton’s Center for International Studies and Beale pursued a law degree.⁷ Over the course of Beale’s “nomadic” post-graduate work experience,⁸ he and Brenner maintained close contact. In 1983, they purchased a two-bedroom vacation home in Cape Cod from Beale’s parents, which had been in the Beale family since the 1960’s.⁹ While Beale has claimed he and Brenner only used the home as a rental,¹⁰ Brenner has explained that until about 1989, the two vacationed at the home roughly once a year.¹¹

³ *Robert Brenner Graduate Alumni Profile*, PRINCETON UNIVERSITY WOODROW WILSON SCHOOL OF PUBLIC AFFAIRS, <http://www.princeton.edu/qzalumni/testimonials/brenner/> (last visited Sept. 9, 2013) (on file with Committee).

⁴ *Compare Robert Brenner Graduate Alumni Profile*, PRINCETON UNIVERSITY WOODROW WILSON SCHOOL OF PUBLIC AFFAIRS, <http://www.princeton.edu/qzalumni/testimonials/brenner/> (last visited Sept. 9, 2013) (documenting Brenner referring to his “best friend from those days, John Beale M.P.A. ‘77.”), with Email from Robert Brenner to John Beale (June 1, 2011, 04:34 EST) (on file with Committee) (“Back in ‘88, I thought I’d get to spend 2 or 3 years working with you on a pretty cool political/policy project. I still can’t believe it turned into 23 years of working with my best friend to try to make some good things happen—I lucked out.”).

⁵ *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov’t Reform*, 113th Cong. (Oct. 1, 2013) (testimony of Robert Brenner) (“John and I met in graduate school . . .”); *id.* (statement of Patrick Sullivan) (“Mr. Brenner and Mr. Beale had attended graduate school together at Princeton University from 1975 to 1979 . . .”); Transcript of John C. Beale Deposition at 11–12, H. Comm on Oversight & Gov’t Reform, 113th Cong. (Dec. 19, 2013) [hereinafter Deposition of John C. Beale], available at <http://oversight.house.gov/wp-content/uploads/2014/01/Beale-Deposition.pdf> (“We [Beale and Brenner] had been friends. We were in graduate school together and had known each other since about 1975.”).

⁶ See Sentencing Memorandum of John C. Beale at 4, United States v. Beale, No. 1:13-cr-00247-ESH (D.D.C. Sept. 27, 2013); John C. Beale, Application for Vacancy Announcement Number EPA-00-SL-OAR-6174 (Apr. 13, 2000); 2013 *Brenner Alumnus Profile* (mentioning “John Beale M.P.A. ‘77.”); *Alumnus Profile: Robert Brenner*, PRINCETON UNIVERSITY WOODROW WILSON SCHOOL OF PUBLIC & INTERNATIONAL AFFAIRS, <http://www.princeton.edu/alumni/stay-connected/what-alumni-are-up-to/brenner-robert> (last visited Jan. 29, 2014).

⁷ See Sentencing Memorandum of John C. Beale, *supra* note 4, at 4; John C. Beale, Application for Vacancy Announcement Number EPA-00-SL-OAR-6174 (Apr. 13, 2000); *Welcome to the NYU Law Alumni Online Community!*, NYU LAW, <https://securelb.imodules.com/s/1068/GroupLaw/index.aspx?sid=1068&gid=3&pgid=8&cid=46&logout=1> (search “Beale”) (last visited Feb. 5, 2014) (listing John Beale as a 1979 alumnus).

⁸ Deposition of John C. Beale, *supra* note 3, at 12 (“I tended not to hold jobs for a very long period of time. I tended to be a very nomadic type of person.”).

⁹ Search for Property Records of John C. Beale (LEXIS); see also *Search for Property Records of John C. Beale*, MASSACHUSETTS LAND RECORDS, <http://www.masslandrecords.com>.

¹⁰ See Deposition of John C. Beale Deposition, *supra* note 3, at 32.

¹¹ *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov’t Reform*, 113th Cong. (Oct. 1, 2013) (testimony of Robert Brenner) (“[F]rom the early 1980’s

It was well known within EPA that Brenner and Beale “spen[t] a lot of time together outside of work going out to eat, playing golf and going on vacations together.”¹² This fact is corroborated by several email exchanges obtained by the Committee. For example, in one email exchange from November 2011, Brenner says to Beale:

It would be great to see you Saturday night-- we'll have the Razor episode queued up and ready to roll! Do I remember correctly--Nancy is travelling[sic]?¹³

This email was forwarded to Beale with a renewed request for the pleasure of his company by Brenner's wife:

John! You're here? Please come over...I'll make brownies. Barb¹⁴

Beale and Brenner also scheduled regular breakfasts and lunches that continued through the end of their tenures at EPA and continued into 2012, after Beale had allegedly retired from EPA.¹⁵ In an email sent on February 14, 2012, Beale wrote Brenner this note:

We made it back and had a great time. If you have the time breakfast would be great. Is there a morning that works best for you?¹⁶

In another email sent on April 7, 2012, Beale asked Brenner, “Would Tues or Wed work for y to have breakfast?”¹⁷ Moreover, Beale, Brenner, and their respective wives socialized frequently, arranging get-togethers ranging from frequent dinners¹⁸ to Valentine's Day celebrations¹⁹ to volunteering for the Obama presidential campaign.²⁰ For example, in an email exchange starting on December 15, 2011, Beale asks Brenner, “Are you and Barb able to do a Friday night this

until about 1989, we [Brenner and Beale] saw each other about once a year at a vacation home we co-owned in Massachusetts”).

¹² See, e.g., Memorandum of Interview of Addie Johnson from Off. of Inspector Gen, U.S. Env'tl. Protection Agency 3 (Apr. 10, 2013) (on file with Committee).

¹³ See E-mail from Barbara Brenner to John Beale (Nov. 29, 2007, 14:49 EST) (on file with Committee).

¹⁴ *Id.*

¹⁵ See, e.g., Email from John Beale to Robert Brenner (Apr. 7, 2012, 10:01 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Feb. 14, 2012, 12:32 EDT) (on file with Committee); E-mail from John Beale to Robert Brenner (Jan. 25, 2012, 04:22 EDT) (on file with Committee); Email from John Beale to Robert Brenner (Apr. 7, 2012, 10:01 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Nov. 5, 2011, 08:51 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Oct. 29, 2008, 02:41 EST).

¹⁶ E-mail from John Beale to Robert Brenner (Feb. 14, 2012, 00:32 EST) (on file with Committee).

¹⁷ E-mail from John Beale to Robert Brenner (Apr. 7, 2012, 10:01 EST) (on file with Committee).

¹⁸ See, e.g., E-mail from John Beale to Robert Brenner (Dec. 16, 2011, 11:35 EST) (on file with Committee); E-mail from Robert Brenner to John Beale (Nov. 6, 2008, 10:02 EST); Email from Robert Brenner to John Beale (Sept. 25, 2008, 14:08 EST) (on file with Committee); E-mail from Robert Brenner to John Beale (July 20, 2008, 01:49 EST) (on file with Committee); E-mail from Barbara Brenner, wife of Robert Brenner, to John Beale (Nov. 29, 2007, 14:49 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Nov. 6, 2006, 09:27 EST) (on file with Committee).

¹⁹ See Email from John Beale to Robert Brenner (Feb. 14, 2012, 12:32 EST) (on file with Committee).

²⁰ See E-mail from Nancy Kete to Robert Brenner, John Beale, and Barbara Brenner (Nov. 4, 2008, 11:30 EST) (on file with Committee).

weekend?”²¹ to which he responds: “I forgot--Friday night does not necessarily mean Friday night! But in this case it’s the case that works best for us.”²²

After working at the EPA together for more than two decades—an experience that Brenner described to Beale as having “lucked out” by spending “23 years of working with my best friend to try to make some good things happen”²³—the two planned a joint retirement party in September 2011,²⁴ which was paid for on Brenner’s wife’s credit card.²⁵ Along with Beale and Brenner, another career EPA official from the Office of Air and Radiation, Jeffrey Clark, decided to retire with them.²⁶ In reference to the retirement party, Beale explained that he, Brenner, and Clark had “kind of all been like the three Musketeers on the Clean Air Act.”²⁷

Brenner Looked out for Beale at EPA

Evidence suggests that Beale and Brenner worked closely together for much of their career, during which time Brenner served as an advocate for Beale. Not only did Brenner hire Beale to his first position with the Agency, but he also requested the EPA pay him at an abnormally high rate. In 1988, when Brenner became the Director for the Office of Policy Analysis and Review (OPAR) within the Office of Air and Radiation, he landed Beale a job as a full-time consultant to the OPAR team.²⁸ By June 1989, Brenner hired Beale as “a permanent, career EPA employee with the position of Policy Analyst in OPAR.”²⁹ At the time, Brenner prepared an “Advance in Hire” memorandum that stated Beale would not accept the position unless he started at the GS-15 Step 10³⁰—the maximum general service pay level.³¹ It is extremely rare to start at this pay grade.³² In addition, the OIG revealed that Beale’s initial application for employment included falsified information that Brenner relied on in hiring

²¹ See E-mail from John Beale to Robert Brenner (Dec. 16, 2011, 11:35 EST) (on file with Committee).

²² See *id.*

²³ E-mail from Robert Brenner to John Beale (June 1, 2011, 04:34 EDT) (on file with Committee).

²⁴ *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov’t Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan).

²⁵ See E-mail from Staff, Off. of Inspector Gen., U.S. Envtl. Protection Agency, to Republican Staff, U.S. Senate Comm. on Env’t & Pub. Works (Nov. 15, 2013, 14:08 EST) (on file with Committee).

²⁶ See Deposition of John C. Beale, *supra* note 3, at 191.

²⁷ *Id.*

²⁸ Sentencing Memorandum of John C. Beale, *supra* note 4, at 5.

²⁹ *Id.* at 7. However, the OIG asserts that Beale was hired as a Senior Policy Advisor. *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov’t Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan).

³⁰ *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov’t Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan).

³¹ See OFF. OF PERSONNEL MGMT., RATES OF PAY UNDER THE GENERAL SCHEDULE EFFECTIVE THE FIRST PAY PERIOD BEGINNING ON OR AFTER JANUARY 1, 1989, *available at* http://archive.opm.gov/oca/pre1994/1989_Jan_GS.pdf (documenting the General Schedule for the year Beale was hired). Grades beyond GS-15, Step 10 were eliminated in 1978. See Civil Service Reform Act of 1978, Pub. L. No. 95-454, 92 Stat. 1111 (codified as amended at 5 U.S.C. ch. 11 (2006)).

³² See U.S. MERIT SYSTEMS PROTECTIONS BOARD, IN SEARCH OF HIGHLY SKILLED WORKERS: A STUDY ON THE HIRING OF UPPER LEVEL EMPLOYEES FROM OUTSIDE THE FEDERAL GOVERNMENT (2008), *available at* <http://www.mspb.gov/netsearch/viewdocs.aspx?docnumber=323118&version=323564&application=ACROBAT> (documenting how rarely civil servants are hired at the higher pay grades).

Beale.³³ Accordingly, the OIG has questioned his initial employment offer and pay level, and has subsequently initiated an audit into the vetting process for new employees at EPA.³⁴

In addition to hiring Beale and offering him a generous salary, Brenner also nominated Beale for several awards and bonuses — both during the time Brenner served as his direct supervisor, as well as when he was Beale's equal.³⁵ While it does not appear that fraud was involved in the facilitation of every bonus award, the facts do give rise to serious concerns for Beale's 1991 and 2000 retention incentive bonus. Specifically, Brenner's recommendation for Beale to receive the 1991 bonus indicated that Beale had received outside offers of employment, yet the OIG uncovered that Beale in fact, had received no written firm offer from an outside company.³⁶ While the OIG has explained that written documentation is not required for such bonus requests, a supervisor submitting the bonus request must perform due diligence to ensure an outside offer exists.³⁷ Brenner has testified that he was not able to recall how he verified that Beale had an outside offer, but explained that, "I either talked to the employer or have received a letter. But I know that without one of those two things being in place, there is no way it could have been approved."³⁸

However, Beale's own testimony contradicts his best friend, as he claims that no one at EPA ever asked him for proof that he, in fact, had a job offer. Beale revealed that he never even asked for the bonuses. According to the exchange below, the retention bonuses were just provided to him without his prompting:

Q Okay, did Mr. Brenner or anyone else at EPA ever offer -- or ask for concrete proof from you of these job offers in '91, '94 or 2000, like documentation of an offer?

A These offers during this period of time would come in, or people would approach me several times a year with things, and it was common knowledge because I talked to people about it. I was thinking about leaving. I'm not -- I'm always amazed I've been in Washington this long. So my recollection is that we had a concrete letter of offer from my law firm, my former law firm. My recollection is that all the other offers were verbal, and although I kind of listened to them initially, they never got to the seriousness where I would have had to talk to the ethics folks about it.

³³ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov't Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan).

³⁴ *Id.* (statement of Arthur Elkins).

³⁵ *Id.* (statement of Patrick Sullivan).

³⁶ *Id.* (testimony of Patrick Sullivan) ("Mr. Brenner's recommendations that Mr. Beale receive the bonuses indicated that Mr. Beale had received outside offers of employment. However, supporting documents available for the six years that Mr. Beale may have been eligible to receive the bonuses did not include written proof of such offers. Mr. Beale conceded in an interview with the OIG on June 14, 2013, that he had not, in fact, received any written offers of employment to support either bonus. Rather, he said, he had received only oral offers for outside employment.").

³⁷ *Id.*

³⁸ *Id.* (testimony of Robert Brenner)

Q Did you ever ask Mr. Brenner or any other EPA official to recommend you, submit applications or authorize you to receive a retention bonus, or were they always extended to you?

A I never asked.

Q You never asked. And no one ever asked for proof of an outside offer. It was just generally known; is that correct?

A To the best of my recollection, that's correct. I can't say for sure, but that's my recollection.³⁹

Accordingly, it appears likely that Brenner requested Beale's retention bonus without conducting appropriate due diligence.

EPW Republicans have uncovered additional concerns with representations made in the 2000 bonus application, which failed to disclose the fact that Beale had previously received a retention bonus.⁴⁰ While it does not appear that then Assistant Administrator Perciasepe had knowledge of Beale's prior bonus history, Brenner certainly did. The penalty for forging or falsifying official government records or documents carries a range of penalties from written reprimand to removal.⁴¹ While the evidence suggests that this document was falsified, no one at EPA has been held accountable.

Around the same time Brenner requested a reauthorization of Beale's bonus, Brenner also recommended Beale for a promotion to Senior Leader ("SL") status, a designation equivalent to Senior Executive Service for technical professionals in the federal government pay system.⁴² As such, less than two months after Beale received the reauthorization for his Retention Incentive Bonus, on August 23, 2000, Beale received the promotion to SL, making Beale among the highest paid, non-elected federal government employees.⁴³ Notably, the promotion and bonuses Brenner requested eventually elevated Beale's salary to exceed the statutory threshold for employees at his pay grade for four years.⁴⁴

Thereafter, Brenner and Beale were equal in rank, but Brenner continued to advocate for his best friend. For example, in 2004, Brenner nominated Beale for a Superior Accomplishment

³⁹ Deposition of John C. Beale, *supra* note 3, at 38–39.

⁴⁰ See Memorandum from Republican Staff, S. Comm. on Env't & Pub. Works, to Republican Members, S. Comm. on Env't & Pub. Works, Additional Facts Regarding EPA Negligence in Responding to Beale Fraud (Bob Perciasepe) (Feb. 5, 2014).

⁴¹ Env'tl. Protection Agency Order 3120.1, *Conduct and Discipline*.

⁴² *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov't Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan).

⁴³ Statement of the Offense at 2, *United States v. Beale*, No. 1:13-cr-00247-ESH (D.D.C. Sept. 27, 2013).

⁴⁴ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov't Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan) ("Based upon his Senior Leader status and retention incentive bonuses, from 2000 to 2013, Mr. Beale was paid, on average, \$180,000 per year, an amount that exceeded statutory pay limits for federal employees at his grade for four of those years – 2007, 2008, 2009 and 2010.").

Recognition Award, which was accompanied by a \$2,250 payment.⁴⁵ In 2005, Brenner also nominated Beale for the Meritorious Executive Rank Award, a category of the Presidential Rank Award, which carried a \$28,201 payment.⁴⁶ While it does not appear that fraud was involved in the facilitation of these awards, the facts illustrate that Brenner was directly involved in Beale's lavish income as a federal employee.

Brenner Covering for Beale

In 1994, while Brenner was Beale's supervisor, Beale assumed the false identity of a CIA agent. According to Beale, he perpetrated this lie to "puff up the image of [himself]."⁴⁷ For a period of this time, public records indicate Beale lived with Brenner at his home in Arlington, Virginia for over a year between 1995 and 1996.⁴⁸ This time together perhaps gave Brenner insight into Beale's comings and goings. It might also help to explain why EPA staff looked to Brenner to confirm Beale's stories. According to Deputy Assistant Administrator Beth Craig, she specifically recalled asking Mr. Brenner if Mr. Beale worked for the CIA and was told "yes."⁴⁹ She accepted Brenner's statement as confirmation of Beale's claim.⁵⁰

Beginning in 2000, the same year Brenner promoted Beale to SL and requested a reauthorization of Beale's bonuses, Beale admittedly "began to engage in a pattern of time and attendance fraud in violation of 18 U.S.C. §641," by taking one unauthorized day off each week for "D.O. Oversight."⁵¹ "D.O." refers to the Directorate of Operations, which is responsible for covert operations at the CIA.⁵² "Beale did not submit request for annual leave for this time, and did not inform his supervisors, [including Brenner], as to the reason for his absences,"⁵³ but was never reprimanded for his time out of the office.⁵⁴ According to EPA's Conduct and Discipline Manual, failure to report to duty for more than five consecutive days is a fire-able offense.⁵⁵ However, according to notes from an interview with Beth Craig, she said it is important to understand that everything was corroborated by Robert Brenner about John Beale. When she had asked Mr. Brenner questions about Mr. Beale's attendance and health, she would be told that John will be in tomorrow... he is feeling better.⁵⁶

⁴⁵ *Id.*

⁴⁶ *Id.*

⁴⁷ *Id.*; see also Transcript of John C. Beale Deposition, *supra* note 3, at 27 (indicating that Beale invented the CIA lie based on his "fantasy").

⁴⁸ See Search for Property Records of John C. Beale (LEXIS); Search for Property Records of Robert Brenner (LEXIS).

⁴⁹ Memorandum of Interview of Elizabeth Craig from Off. of Inspector Gen, U.S. Evtl. Protection Agency 3 (Apr. 10, 2013) (on file with Committee).

⁵⁰ *Id.*

⁵¹ Sentencing Memorandum of John C. Beale, *supra* note 4, at 16.

⁵² *Id.*

⁵³ Statement of the Offense, *supra* note 46, at 2.

⁵⁴ See *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov't Reform*, 113th Cong. (Oct. 1, 2013) (statement of Patrick Sullivan).

⁵⁵ Evtl. Protection Agency Order 3120.1, *Conduct and Discipline*.

⁵⁶ Memorandum of Interview of Elizabeth Craig from Off. of Inspector Gen, U.S. Evtl. Protection Agency 3 (Apr. 10, 2013) (on file with Committee).

Starting in June 2008, Beale also failed to report to work at EPA for about six months.⁵⁷ During this period of time he never submitted a leave request and continued to receive his EPA salary.⁵⁸ Throughout his absence, he claimed to be working on the research project or spending time working for “Langley” on candidate protection for the CIA.⁵⁹ However, the record suggests that Brenner was privy to the fact that Beale was not on a special mission. Rather, Beale was in the Washington, D.C. area, meeting regularly with Brenner. For example, in email exchanges dated August 5, 2008, and October 29, 2008, the two make plans to get together for breakfast,⁶⁰ and on September 25, 2008, the two made plans for dinner and to watch the Presidential debate.⁶¹ In light of Beale’s claim to be on assignment protecting presidential candidates, it is odd that Brenner failed to question Beale’s availability on the evening of the presidential debate. Even more, Beale and Brenner had plans to meet on election night, as evidenced by a note from Brenner to Beale:

No problem--we'll eat whenever you arrive. And hopefully it will be time to break out the champagne by shortly after the 8:00 polls close. See you tonight, Rob.⁶²

Despite these frequent visits during Beale’s extended absence at EPA, there is no evidence that Brenner raised any concerns at EPA over the missing employee.

Brenner’s Failure to Cooperate with Congress

Even after Beale’s fraud was exposed, it appears Brenner still has his best friend’s back. To date, Brenner has refused to be interviewed by EPA’s OIG and has been as equally uncooperative in his dealings with Ranking Member Vitter. In response to a series of questions posed in a letter from Ranking Member Vitter,⁶³ Brenner responded with only short, perfunctory answers to a few of the questions, frequently citing his prepared statement for the House Committee on Oversight and Government Reform hearing, and repeatedly asserting that he was “unable to recount” or “recall” the answers to the fairly easy questions.⁶⁴ When Ranking Member Vitter requested specific answers from Brenner, he followed up with a letter announcing his refusal to cooperate with the Senate investigation.⁶⁵

⁵⁷ Statement of the Offense, *supra* note 46, at 4.

⁵⁸ *Id.*

⁵⁹ See Deposition of John C. Beale, *supra* note 3, at 146 (“I did make up this story that I was going to be working on a special process for the agency on executive protection.”).

⁶⁰ E-mail from John Beale to Robert Brenner (Oct. 29, 2008, 02:41 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Aug. 5, 2008, 18:15 EST) (on file with Committee).

⁶¹ Email from Robert Brenner to John Beale (Sept. 25, 2008, 14:08 EST) (on file with Committee).

⁶² E-mail from Robert Brenner to John Beale (Nov. 4, 2008, 09:24 EST) (on file with Committee).

⁶³ See Letter from the Hon. David Vitter, Ranking Member, S. Comm. on Env’t & Pub. Works, to Robert Brenner (Sept. 9, 2013).

⁶⁴ See Letter from Justin Shur, Counsel to Robert Brenner, to Kristina Moore, Senior Counsel for Oversight, S. Comm. on Env’t & Pub. Works (Oct. 4, 2013) (citing *Secret Agent Man? Oversight of EPA’s IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov’t Reform*, 113th Cong. (Oct. 1, 2013) (statement of Robert Brenner)).

⁶⁵ Letter from Justin Shur, Counsel to Robert Brenner, to Kristina Moore, Senior Counsel for Oversight, S. Comm. on Env’t & Pub. Works (Nov. 8, 2013).

Conclusion

As this memorandum demonstrates, Robert Brenner and John Beale were tied at the hip in both their professional lives and personal lives. Evidence suggests that Brenner played a pivotal role in enabling Beale's fraud, whether that fraud was accepting unearned bonuses, stealing time from EPA, or impersonating a CIA official, Brenner's actions both enabled and covered for John Beale. It is unclear whether Brenner's actions were done with the intent of aiding and abetting Beale's crimes or out of willful ignorance. Either way, Brenner should be called on to account for his actions.

BARBARA BOXER, CALIFORNIA, CHAIRMAN
 MAX BADESCU, MONTANA
 THOMAS R. CARPER, DELAWARE
 BENJAMIN L. CARDIN, MARYLAND
 BERNARD SANDERS, VERMONT
 SHELLEY M. MOYER, RHODE ISLAND
 TOM COONS, NEW MEXICO
 JEFF MERKLEY, OREGON
 KRISTEN GILLIBRAND, NEW YORK
 CORNYA A. BUCKNER, NEW JERSEY

DAVID VITTER, LOUISIANA
 JAMES M. INHOFE, OKLAHOMA
 JOHN SHARRIS, WYOMING
 JEFF SESSIONS, ALABAMA
 MIKE CRAPPO, IDAHO
 BOB CORKER, MISSISSIPPI
 JOHN BOGDMAN, ARKANSAS
 DEB FISCHER, NEBRASKA

United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
 WASHINGTON, DC 20510-6125

DETTINA POMER, MAJORITY STAFF DIRECTOR
 ZAY SASSI, REPUBLICAN STAFF DIRECTOR

MEMORANDUM

TO: Republican Members of the Senate EPW Committee
FROM: Republican Committee Staff
DATE: February 7, 2014
RE: Questions Relating to EPA Negligence in Responding to Beale Fraud (Additional Individuals)

Background

The Committee on Environment and Public Works (EPW) Republican Staff issued a series of memoranda identifying and sharing previously undisclosed information about the actions, or more often inaction, of Environmental Protection Agency (EPA) officials who had an opportunity to prevent John Beale from perpetrating his fraud at the Agency. The memoranda raise questions over EPA Administrator Gina McCarthy's decision to wait over three and a half years after she first grew suspicious to probe Beale's claim to be a CIA agent, and why she was slow to stop payment on Beale's unearned bonuses.¹ In the case of EPA Deputy Administrator, Bob Perciasepe, EPW staff revealed additional facts that raise questions as to his involvement in Beale's 2000 bonus and receipt of unearned pay, as well as the delay in cancelling Beale's bonus.² Then, EPW staff detailed the close relationship between another top EPA official, former Deputy Assistant Administrator Robert Brenner and John Beale, which raised important questions about Brenner's culpability in Beale's fraud.³ This memorandum will present information involving additional EPA officials who played a prominent role in shaping EPA's response to Beale's fraud. Specifically, EPW Republicans have put into context the actions of Deputy Assistant Administrator for the Office of Air and Radiation (OAR) Beth Craig, Assistant Administrator for the Office of Administration and Resources Management (OARM) Craig Hooks, and Director of Human Resources within OAR Scott Monroe.

Beth Craig

Beth Craig was a Deputy Assistant Administrator (Deputy AA) in the Office of Air and Radiation at EPA from 2000 to 2010.⁴ In this position "she worked very closely with [John]

¹ Memorandum from Republican Members of S. Env't. & Pub. Works Comm. to Republican Comm. Staff, on Facts Regarding Beale Fraud (McCarthy) (Feb. 4, 2014).

² Memorandum from Republican Members of S. Env't. & Pub. Works Comm. to Republican Comm. Staff, on Facts Regarding Beale Fraud (Perciasepe) (Feb. 5, 2014).

³ Memorandum from Republican Members of S. Env't. & Pub. Works Comm. to Republican Comm. Staff, on Facts Regarding Beale Fraud (Brenner) (Feb. 6, 2014).

⁴ Notes of Bill Spinazzola, Office of Inspector Gen., Env't'l. Prot. Agency, on Interview with Elizabeth Craig 2 (Nov. 12, 2013).

Beale and [Robert] Brenner ... having daily meetings with the two men.”⁵ Among Craig’s responsibilities, she reviewed and approved Beale’s travel vouchers.⁶ Additionally, Craig had a role in the approval of Beale’s timecards, even when he was out of the office for long periods.⁷ In the ten year period in which she served as Deputy AA, she has admitted that she “held [him] to a different standard.”⁸

Indeed, Craig approved Beale’s travel vouchers even when the vouchers requested reimbursement for excessive costs, contained personal charges, and sometimes did not have completed itineraries.⁹ Craig approved one voucher that exceeded \$37,000,¹⁰ and she routinely approved vouchers that “exceeded ... \$20,000 for a single trip.”¹¹ According to Beale’s administrative assistant, “Craig would ask if Beale could get some of the expenses ... cheaper ... but Craig would still allow the expenses to be processed and approved.”¹² In fact, Craig admitted that she handled Beale’s vouchers “differently than others” and essentially did not review them.¹³ Instead she “relied on the administrative staff to review specific trip details and receipts”¹⁴ However, when Beale’s Executive Assistant raised concerns over “the excessive and abusive nature of Mr. Beale’s travel expenses,” Craig told her “not to question the expenses, which were authorized because Mr. Beale was a senior level official.”¹⁵

Craig also had the authority and responsibility to approve Beale’s timecards.¹⁶ Documents obtained by the Committee suggest that she approved and instructed staff to record and approve Beale’s hours, even during the period of time when he did not report to EPA offices for six months.¹⁷ Beale’s administrative assistant was instructed at different times by both Beale and Craig “to put Beale in for eighty (80) hours of work each pay period unless instructed otherwise.”¹⁸ When Beale’s assistant brought her concerns about Beale’s absences and the time entries to Craig, Craig explained to her that “Beale worked for EPA, but from a different

⁵ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Elizabeth Craig 1 (Mar. 7, 2013).

⁶ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Elizabeth Craig 1 (June 18, 2013).

⁷ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Omayra Salgado 3 (May 13, 2013).

⁸ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Elizabeth Craig 2 (June 18, 2013).

⁹ *Id.* at 1-2.

¹⁰ *Id.* at 2.

¹¹ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Addie Johnson 3 (Apr. 10, 2013).

¹² *Id.* at 2.

¹³ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Elizabeth Craig 3 (June 18, 2013).

¹⁴ *Id.*

¹⁵ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. on Oversight and Government Reform*, 113th Cong. 6 (2013) (Written Testimony of Patrick Sullivan, Assist. Inspector Gen. for Investigations, Env'tl. Prot. Agency).

¹⁶ Beale Dep. 139:1-140:7 (Dec. 19, 2013).

¹⁷ Beale Dep. 144:21-145:13.

¹⁸ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, on Interview with Addie Johnson 1 (Apr. 10, 2013).

location.”¹⁹ Additionally, the former director of Human Resources within OAR Omayra Salgado stated:

Beth Craig ... knew Beale was not around and that time cards were getting approved. Salgado told Craig that she (Salgado) was approving timecards for Beale, but because he was often absent, Salgado did not understand why she was continuing to approve his timecards. Craig told her that Beale worked for the CIA and Salgado never asked anyone else about it because Craig explained things and Salgado felt that was enough.²⁰

Accordingly, it is apparent that Craig bent several of EPA’s rules to accommodate Beale because of their close relationship and because she believed in his CIA cover story.

Craig Hooks

In an effort to justify her slow response to Beale’s fraud, Administrator Gina McCarthy has maintained that she relied on OARM’s advice in determining how to respond to the questions surrounding Beale, and that in her opinion, “the Beale matter was not a high priority for” OARM.²¹ A review of the facts suggests that the public narrative regarding Hooks’ role oversimplifies the decision making process that occurred between the time Beale’s pay issues were first discovered in July 2010 and April 2013, when Beale was allowed to voluntarily retire. At the time, Craig Hooks was the Assistant Administrator for OARM and thus was McCarthy’s peer. According to Hooks, “[he] had to give deference to Beale as a result of his position and reputation within EPA and OAR. Beale was a Deputy Assistant Administrator with a history of good work and that no actions were going to be taken without the facts to support them.”²²

According to documents obtained by the Committee, Hooks first learned of Beale’s pay issues in mid-2010.²³ Thereafter, OARM consulted with OAR on the issue of Beale’s bonuses and independently began an inquiry into whether or not Beale had adequate documentation for the bonuses. In January 2011, Hooks told McCarthy he wanted to consult with Deputy Administrator Perciasepe because he was the last official to sign off on Beale’s bonus in 2000. It appears that Hooks also raised the issue of Beale’s pay and absences to the Inspector General in a senior staff meeting. He was advised by Elkins at that time that the issue appeared to be a personnel issue and that the agency should handle it.²⁴ Elkins has corroborated these statements.²⁵ Finally, Hooks reviewed Beale’s personnel file and found there was nothing in Beale’s folder that would suggest he was CIA, though there was an SF-52 document signed by

¹⁹ *Id.* at 2.

²⁰ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env’tl. Prot. Agency, on Interview with Omayra Salgado 3 (May 13, 2013).

²¹ Notes of Robert Adachi, Dir. Forensic Audit Prod. Line, Env’tl. Prot. Agency, on Interview with Gina McCarthy 2 (Nov. 18, 2013).

²² Notes of Robert Adachi, Dir. Forensic Audit Prod. Line, Env’tl. Prot. Agency, on Nov. 14, 2013 Interview with Craig Hooks 3 (Nov. 18, 2013).

²³ *Id.* at 2.

²⁴ Notes of Kevin Collins, Auditor, Env’tl. Prot. Agency, on Interview with Susan Kantrowitz 2 (Nov. 13, 2013).

²⁵ Notes of Robert Adachi, Dir. Forensic Audit Prod. Line, Env’tl. Prot. Agency, on Nov. 14, 2013 Interview with Craig Hooks 2 (Nov. 18, 2013).

the Administrator, which was very unusual and lead him to believe the CIA story might be true.²⁶ According to OARM officials, Hooks was also checking “that the White House is aware and there will not be any political fallout” from canceling Beale’s bonus.²⁷

However, in early 2011, Nancy Dunham with the Office of General Counsel (OGC) instructed employees in OARM to not use Beale’s name in any documentation and to stop sending emails and other correspondence until they could confirm whether or not Beale had a “relationship with the CIA or intelligence community.”²⁸ Pursuant to Dunham’s instructions, OGC further instructed OARM “to keep hands off the Beale issue until further notice.”²⁹ An OARM official stated that based on instructions from OGC “her office stopped all work on the issue.”³⁰ Following OGC’s instructions, Hooks also told McCarthy to “hold any information exchange” with Beale.³¹ According to Hooks, he “did not want to get in Beale’s way or to compromise national security issues. That is why the matter was referred to the Office of General Counsel (OGC), Nancy Dunham in particular.”³² Thereafter, the “OGC never got back to Hooks, and ... Hooks” decided that until OGC advised him otherwise, he would not take further action.³³ For several months, no action was taken. When Beale announced his plans to retire in May 2011, it appears everyone thought the problem was solved.

When Scott Monroe discovered that Beale was still on payroll in March 2012, McCarthy immediately contacted Hooks. At the time, Hooks was surprised the situation had not already been handled. However, per the previous instructions by Nancy Dunham, Hooks deferred to OGC. According to Nancy Dunham, the Beale matter, “was considered a routine question involving pay and that it was not until the facts determined that he was not a CIA employee that the matter was referred to the OIG in Feb. 2013.”³⁴

Until this point, the question that was being raised was about the retention bonus. Therefore, there was no sense of urgency about the situation. The problem was lack of paperwork surrounding the bonus. After November 2012, the lack of attendance also became an issue.³⁵ (emphasis added)

In the end, it appears that Hooks was doing his job, but experienced significant interference from the OGC, as well as misguided advice from the OIG. Despite his efforts, Hooks should not be excused for the nearly two year delay in handling Beale’s pay issues, but

²⁶ *Id.*

²⁷ E-mail from Susan Smith, Envtl. Prot. Agency, to Karen Higginbotham, Envtl. Prot. Agency (Feb. 1, 2011 01:09 PM).

²⁸ Notes of Kevin Collins, Auditor, Envtl. Prot. Agency, on Interview with Susan Kantowitz 2 (Nov. 13, 2013).

²⁹ *Id.*

³⁰ *Id.*

³¹ E-mail from Gina McCarthy, Assist Adm’r, Office of Air & Radiation, Envtl. Prot. Agency, to Scott Monroe, Dir. Human Res. Office of Air and Radiation, Envtl. Prot. Agency (Jan., 17, 2011 01:31 PM).

³² Notes of Robert Adachi, Dir. Forensic Audit Prod. Line, Envtl. Prot. Agency, on Nov. 14, 2013 Interview with Craig Hooks 2 (Nov. 18, 2013).

³³ *Id.*

³⁴ Notes of Robert Adachi, Dir. Forensic Audit Prod. Line, Envtl. Prot. Agency, on Interview with Brenda Mallory 2 (Nov. 18, 2013).

³⁵ *Id.*

questions remain as to what direction, if any, he received from Dunham, Perciasepe or other senior officials in early 2011.

Scott Monroe

Scott Monroe became the Director of Human Resources in the Office of Air and Radiation in 2008.³⁶ In this role, Monroe was responsible for overseeing Beale's timecards, and dealing with general personnel matters regarding OAR employees.³⁷ Monroe began to "notice that Beale was never in the office" soon after he starting at OAR.³⁸ In 2008, Beale was not in the office for six months, but continued to collect his full salary plus bonus.³⁹ During this time Monroe approved Beale's timecards as part of a "mass approval to the [employee] group Beale was in."⁴⁰ According to Monroe, he gave mass approval to the group because there were too many to do individual approvals.⁴¹

In 2010, Monroe became aware that Beale's retention bonus was causing his salary to exceed statutory limitations.⁴² Acting on this information, Monroe sent an email to Beth Craig on July 16, 2010, with a report detailing the extent of the problems with Beale's retention bonus and salary.⁴³ He then reviewed "Beale's file and saw that the last retention bonus recertification was in 2000[.]" but that the file contained no evidence of an offer that would have justified the retention bonus.⁴⁴ Monroe "did not know why the bonus was continued without recertification."⁴⁵ On December 15, 2010, Monroe contacted OARM, looking for ways to stop payment on Beale's retention bonus.⁴⁶ On January 12, 2011, Monroe raised the issue of Beale's retention bonus with McCarthy and recommended that she take action to cancel the bonus.⁴⁷ McCarthy responded asking Monroe to "put on hold any information exchange re: John Beale and payroll issues..." per Craig Hooks' request.⁴⁸ Monroe checked in with McCarthy on January 27, 2011, to see if she had heard back from Hooks as he was, "eager to move head [sic] with

³⁶ Notes of Bill Spinazzola, Office of Inspector General, Env'tl. Prot. Agency, on Interview with Scott Monroe 2 (Nov. 12, 2013).

³⁷ *Id.* at 2-3.

³⁸ *Id.* at 3.

³⁹ Beale Dep. 139:1-140:7.

⁴⁰ Notes of Bill Spinazzola, Office of Inspector General, Env'tl. Prot. Agency, on Interview with Scott Monroe 3 (Nov. 12, 2013).

⁴¹ *Id.*

⁴² *Id.*

⁴³ E-mail from Scott Monroe, Dir. Human Res., Office of Air & Radiation, Env'tl. Prot. Agency, to Beth Craig, Deputy Assist. Adm'r, Office of Air & Radiation, Env'tl. Prot. Agency, (July 16, 2010 10:02 AM).

⁴⁴ Notes of Bill Spinazzola, Office of Inspector General, Env'tl. Prot. Agency, on Interview with Scott Monroe 4 (Nov. 12, 2013).

⁴⁵ *Id.*

⁴⁶ E-mail from Scott Monroe, Dir. Human Res. Office of Air and Radiation, Env'tl. Prot. Agency to Susan Smith, Env'tl. Prot. Agency (Dec. 15, 2010 11:58 AM).

⁴⁷ Memorandum from Scott Monroe, Dir. Human Res. Office of Air and Radiation, Env'tl. Prot. Agency, to Gina McCarthy, Assist Adm'r, Office of Air & Radiation, Env'tl. Prot. Agency, Regarding John Beale Retention Pay (Jan. 12, 2011).

⁴⁸ E-mail from Gina McCarthy, Assist Adm'r, Office of Air & Radiation, Env'tl. Prot. Agency, to Scott Monroe, Dir. Human Res. Office of Air and Radiation, Env'tl. Prot. Agency (Jan., 17, 2011 01:31 PM).

canceling the bonus.”⁴⁹ McCarthy replied, “No he hasn’t. It’s now in his hands as far as I am concerned.”⁵⁰ Monroe never got the clearance he was seeking to cancel Beale’s bonus.

After Beale’s retirement party in September of 2011, Monroe noticed that Beale was still filing time cards and collecting pay.⁵¹ On March, 29, 2012, Monroe notified McCarthy that it appeared Beale was not retired and still collecting his salary.⁵² For several months, it appears Monroe’s concerns were put in abeyance as McCarthy stalled on contacting Beale to inquire his status. Then, on November 8, 2012, Monroe sent an email to McCarthy detailing that Beale had been “report[ing] an 8-hour regular schedule.”⁵³ Subsequently, McCarthy contacted Beale and eventually the Office of General Counsel, which ultimately led to reporting to the OIG and unraveling Beale’s fraud.

Conclusion

It is evident that there were widespread failures at EPA, across several offices (OAR, OGC, OARM, OIG and the Office of the Administrator) that allowed Beale’s fraud to continue unquestioned for so long. While John Beale is ultimately responsible for his crimes, his lies, and his abuse of his coworkers’ trust, it has become increasingly clear that there is a culture at EPA that is willing to ignore the rules, ignore all protocols, and even ignore all common sense when it came to protecting one of their own. While mistakenly trusting a coworker and a friend is not a crime, and on some level is even understandable, it does not excuse those individuals who looked the other way, who failed to do their due diligence, and who failed to act when the obvious facts were before them. After all, the public trust was broken, not just by John Beale, but by all those at EPA who failed to act when the facts before them should have compelled corrective action.

⁴⁹ E-mail from Scott Monroe, Dir. Human Res. Office of Air and Radiation, Env’tl. Prot. Agency, to Gina McCarthy, Assist Adm’r, Office of Air & Radiation, Env’tl. Prot. Agency (Jan. 27, 2011 05:56 PM).

⁵⁰ E-mail from Gina McCarthy, Adm’r, Office of Air and Radiation, Env’tl. Prot. Agency, to Scott Monroe, Dir. of Human Res., Office of Air and Radiation, Env’tl. Prot. Agency (Jan. 27, 2011 08:24PM EST).

⁵¹ Notes of Bill Spinazzola, Office of Inspector General, Env’tl. Prot. Agency, on Interview with Scott Monroe 4 (Nov. 12, 2013).

⁵² E-mail from Scott Monroe, Dir. Human Res. Office of Air and Radiation, Env’tl. Prot. Agency, to Gina McCarthy, Assist Adm’r, Office of Air & Radiation, Env’tl. Prot. Agency (Mar. 29, 2012 09:59 PM).

⁵³ E-mail from Scott Monroe, Dir. Human Res. Office of Air and Radiation, Env’tl. Prot. Agency, to Gina McCarthy, Assist Adm’r, Office of Air & Radiation, Env’tl. Prot. Agency (Nov. 8, 2012 05:27 PM).

SARAH PAWLEY, CALIFORNIA, CHAIRMAN
 MAX BAUCUS, MONTANA
 THOMAS H. CARPER, DELAWARE
 BEN LAMPSON, CONNECTICUT
 BERNARD SANDERS, VERMONT
 SHELDON WHITEHOUSE, RHODE ISLAND
 TIM WIRTH, NEW MEXICO
 JEFF BLUMENTHAL, CONNECTICUT
 CHRISTEN HILL, IOWA
 CHRIS G. RODDEE, NEW JERSEY

DETTLEA FORBER, SECURITY STAFF DIRECTOR
 GAB BAIG, REPUBLICAN STAFF DIRECTOR

DAVID VITTER, LOUISIANA
 JAMES M. INHOFE, OKLAHOMA
 JOHN BARRASSÉ, WYOMING
 JEFF SESSIONS, ALABAMA
 MIKE CRAPPO, UTAH
 ROGER WICKER, MISSISSIPPI
 JOHN BOOZEMAN, ARKANSAS
 TED CRUZ, TEXAS

United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
 WASHINGTON, DC 20510-6775

MEMORANDUM

TO: Republican Members of the Senate Committee on Environment and Public Works
FROM: Republican Committee Staff
DATE: March 4, 2014
RE: Additional Facts Relating to Beale Controversy and OIG Investigations

In the aftermath of the John Beale conviction, the Environmental Protection Agency (EPA) and the EPA Office of Inspector General (OIG) have seemingly treated the case closed following two OIG early warning reports on Beale's pay and travel issues and Beale's 32-month sentencing in December 2013. Concurrently, the Agency and the OIG have praised Administrator McCarthy's "leadership" on "uncovering" Beale's fraud in her former position as Beale's supervisor, and made representations to the public that Beale was an isolated incident - ostensibly to mitigate any concerns over McCarthy and the Agency's ability to confront waste, fraud and abuse.

Despite these efforts to characterize Beale as an isolated incident, Senate Committee on Environment and Public Works (EPW) Republican staff have learned that time and attendance fraud is widespread at the Agency. Moreover, EPW Republicans now understand that McCarthy was not exactly the hero in this case, and since becoming Administrator she has exacerbated a growing tension between Agency officials and the OIG. These concerns were shared with the OIG in a February 18, 2014, letter and email from Ranking Member Vitter to Inspector General Arthur Elkins. On February 24, 2014, the OIG provided a response letter to Senator Vitter, as well as a briefing to EPW Republican staff.

Subsequently, information provided by the OIG response letter and briefing, as well as additional non-public information obtained by EPW Republican staff, has prompted additional questions about EPA officials. These queries focus on officials in the OIG, Office of General Counsel (OGC) and Office of Homeland Security (OHS), and their role in the Agency's weak response to concerns over Beale, delayed reporting of such concerns to the OIG, and failure to cooperate with the OIG's subsequent investigation and audit. In an effort to keep EPW Republican Members fully informed on these matters, this memorandum synthesizes public information, including recent correspondence from the Agency and OIG, as well as non-public information obtained by EPW Republican staff.

Concerns with Nancy Dunham and the Office of General Counsel

Nancy Dunham, a staff attorney in the EPA's Office of General Counsel (OGC), was a pivotal player in EPA's response to the Beale fraud. In addition, she has become embroiled in a separate but related controversy dealing with the OIG's ability to conduct criminal investigations. It appears McCarthy personally selected Dunham to provide her counsel on the Beale case after McCarthy became aware of Beale's retention incentive bonus problems,¹ possibly in early 2011,² and in doing so gave Dunham full access to her emails related to Beale.³ However, in an interview with the OIG, Dunham claimed she was first made aware of problems related to Beale when human resources contacted the OGC on November 9, 2012.⁴ The OIG has since revealed in a letter to Ranking Member Vitter, that this statement was false and explained that Dunham may have been aware of Beale months and possibly years prior to November 2012.⁵ This admission challenges both the OIG and EPA public assertions that McCarthy first reported her concerns to the OGC, and specifically to Dunham, on the Beale case "on or around November 1, 2012."⁶ Importantly, the OIG is unable to provide any physical evidence, either in the form of email or memorandum, to support this later claim. Rather, the OIG relied on three interviews with EPA officials, including Dunham's deceitful interview and McCarthy's personal account of the facts, to support the narrative that McCarthy was the first to uncover Beale's fraud.⁷ Notably, in forming this conclusion, none of the interviews discuss any date close to November 1, 2012.

New information also gives rise to additional questions about EPA and the OIG's official story on when McCarthy reported her concerns to the OIG. Since McCarthy selected Dunham, who specialized in national security issues, EPA officials involved believed the Beale case was a national security issue.⁸ This determination was communicated to the Office of Administration

¹ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, Interview with Gina McCarthy at 3 (Feb. 27, 2013) ("McCarthy stated that after finding out about the continued payment of the retention incentive to Beale, McCarthy sought legal counsel from Nancy Dunham").

² See Memorandum from Scott Monroe, Office of Human Res., Office of Air & Radiation, Env'tl. Prot. Agency, to Gina McCarthy, Assistant Adm'r, Office of Air & Radiation, Env'tl. Prot. Agency (Jan. 12, 2011) (notifying McCarthy of lack of documentation supporting Beale's retention incentive bonus, noting "OGC advised that EPA should not continue to pay the allowance...").

³ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, Interview with Gina McCarthy at 3 (Feb. 27, 2013).

⁴ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, Interview with Nancy Dunham at 1 (Mar. 28, 2013).

⁵ Letter from Hon. Arthur Elkins, Inspector Gen., Env'tl. Prot. Agency, to Hon. David Vitter, Ranking Member, S. Comm. on Env't & Public Works at 4 (Feb. 24, 2014) ("OA later developed information through other interviews which indicates that Ms. Dunham may have been aware of Mr. Beale's pay issues several months or even a year prior to what she told OI during her interview").

⁶ *Id.* at 2.

⁷ *Id.* at 2-3.

⁸ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Env'tl. Prot. Agency, Interview with Nancy Dunham at 1 (Mar. 28, 2013) ("Dunham stated that she has worked in EPA OGC since 2003

and Resource Management (OARM) and impeded their efforts to settle issues with Beale's pay and bonuses because they "did not wish to get in Beale's way or to compromise any national security issues."⁹ In treating the case as a national security issue, on November 16, 2012, Dunham referred her concerns to Senior Intelligence Advisor Steve Williams at OHS.¹⁰ In this position, Williams is the Agency's liaison with the intelligence community,¹¹ and pursuant to Intelligence Community Directive 304,¹² Williams would have been made aware of any EPA officials jointly employed by the intelligence community. In fact, under Directive 304, which was effective in March 2008, three Agency officials, including the Senior Intelligence Officer, the General Counsel and the Administrator, should be notified of employees with classified relationships with the intelligence community.¹³ Accordingly, Dunham's decision to delay notification to Williams of her concerns regarding Beale's status as a CIA agent is worrisome as Williams was one of the individuals who would have been aware of other CIA operatives at the Agency, pursuant to Directive 304.

Despite Dunham's delayed consultation with OHS, according to new evidence obtained by EPW Republicans, it appears Dunham continued to meddle with the Agency's handling of the matter by taking on an investigatory role herself. Specifically, on the same day she contacted Williams, Dunham spoke with Karen Higginbotham of OARM regarding Beale's lack of documentation, and on December 3, 2012, Dunham interviewed Scott Monroe in the Office of Human Resources within the Office of Air and Radiation, questioning his knowledge of Beale's CIA work.¹⁴ Approximately a week later, Williams informed Dunham that Beale never had a security clearance and it was highly unlikely he worked for CIA.¹⁵ Thereafter, Dunham shared her findings with McCarthy.¹⁶ On January 28, 2013, Dunham reported her concerns of Beale directly to the EPA OIG General Counsel Al Larsen, one of the most senior officials in the OIG.¹⁷ Oddly, the OIG has continued to assert it was not made aware of the Beale matter until

as an Attorney Advisor specializing in employment litigation and national security matters"); *see also* Interview Notes from Office of Inspector Gen., Emtl. Prot. Agency, Interview with Craig Hooks (Nov. 14, 2013).

⁹ Interview Notes from Office of Inspector Gen., Emtl. Prot. Agency, Interview with Craig Hooks (Nov. 14, 2013) ("Hooks said that he did not wish to get in Beale's way or to compromise any national security issues. That is why the matter was referred to the Office of General Counsel, Nancy Dunham in particular. OGC never got back to Hooks and until Hooks heard anything, no actions were going to be taken").

¹⁰ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Emtl. Prot. Agency, Interview with Nancy Dunham at 1 (Mar. 28, 2013); Sworn Statement of Steve Williams at 2 (Mar. 29, 2013).

¹¹ *See* Emtl. Prot. Agency, Office of Homeland Security, Our Responsibility, <http://www.epa.gov/ohs/responsibilities.htm> (last visited Feb. 28, 2014).

¹² OFFICE OF DIRECTOR OF NATIONAL INTELLIGENCE, INTELLIGENCE COMMUNITY DIRECTIVE NO. 304 (effective Mar. 6, 2008), <http://www.fas.org/irp/dni/icd/icd-304.pdf>.

¹³ *Id.*; *see also* Sworn Statement of Steve Williams at 3 (Mar. 29, 2013).

¹⁴ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Emtl. Prot. Agency, Interview with Nancy Dunham at 1-2 (Mar. 28, 2013).

¹⁵ Sworn Statement of Steve Williams at 3 (Mar. 29, 2013).

¹⁶ *Id.*

¹⁷ Memorandum of Interview from Mark Kaminsky, Special Agent, Office of Inspector Gen., Emtl. Prot. Agency, Interview with Nancy Dunham at 3 (Mar. 28, 2013).

February 11, 2013, when McCarthy finally reported the matter.¹⁸ Incidentally, McCarthy was accompanied by Dunham at the meeting with the OIG to discuss concerns over Beale.¹⁹

Dunham herself has served as an obstacle in resolving questions about the delay in reporting the Beale matter to the OIG. When the OIG conducted an audit, pursuant to Ranking Member Vitter's August 27, 2013, request,²⁰ she refused to be interviewed, citing recent issues between Agency and OIG officials.²¹ There is little precedent for a current EPA employee to refuse to cooperate with an OIG audit, yet Dunham has done so with apparently no penalty. Moreover, at the time of her refusal, Dunham's decision was maintained by Acting Principal Associate General Counsel Kevin Minoli in an email and memorandum to the OIG.²² Specifically, Mr. Minoli stated:

I write to inform you that Nancy Dunham has determined she will not make herself available for a second interview with the Office of Inspector General (OIG) regarding the Beale matter, until the agency's efforts to resolve the issues between the OIG and EPA employees who work on national security issues are completed... Ms. Dunham is now concerned that she is in fact the target of an OIG investigation regarding this matter, rather than merely a helpful witness.²³

The Committee has learned that one of the issues Dunham cited in her refusal to cooperate spawned from an altercation between OHS and OIG employees to which Dunham was a witness.²⁴ In response to that heated exchange, McCarthy wrote to both the OIG and OHS ordering them to stand down from an investigation of both the incident, as well as the underlying investigation.²⁵ Troublingly, this letter suggests that the Inspector General is a subordinate to McCarthy and not the Presidential appointee of an independent entity within the Agency. Moreover, in his letter to the OIG, Deputy Administrator Bob Perciasepe characterized McCarthy's stand down letter as having no relation to the Beale matter.²⁶ However, such

¹⁸ Letter from Hon. Arthur Elkins, Inspector Gen., Env'tl. Prot. Agency, to Hon. David Vitter, Ranking Member, S. Comm. on Env't & Public Works at 2 (Feb. 24, 2014).

¹⁹ Memorandum from Douglas Zmorzenski, Special Agent in Charge, Office of Inspector Gen., Env'tl. Prot. Agency, to Patrick Sullivan, Assistant Inspector Gen., Office of Investigations, Office of Inspector Gen., Env'tl. Prot. Agency (Feb. 12, 2013) ("The employee investigation was reported to you during a meeting with Gina McCarthy, EPA, Assistant Administrator, Office of Air and Radiation and Nancy Dunham, EPA, Attorney, Office of General Counsel").

²⁰ Letter from Hon. David Vitter, Ranking Member, S. Comm. on Env't & Public Works, to Hon. Arthur Elkins, Inspector Gen., Env'tl. Prot. Agency (Aug. 27, 2013).

²¹ Notes from Office of Inspector Gen., OGC Staff Member – Refusal of Interview (Nov. 26, 2013).

²² *Id.*

²³ Email from Kevin Minoli, Acting Principal Assoc. Gen. Counsel, Office of Gen. Counsel, Env'tl. Prot. Agency, to Robert Adachi, Office of Audit, Office of Inspector Gen., Env'tl. Prot. Agency (Nov. 21, 2013, 06:32 AM EST).

²⁴ Briefing by Office of Inspector Gen., Env'tl. Prot. Agency for Republican Staff, S. Comm. on Env't & Public Works (Feb. 24, 2014).

²⁵ Letter from Gina McCarthy, Adm'r, Env'tl. Prot. Agency, to Arthur Elkins, Inspector Gen., Env'tl. Prot. Agency & Juan Reyes, Acting Assoc. Adm'r, Office of Homeland Security, Env'tl. Prot. Agency (Oct. 28, 2013).

²⁶ Letter from Bob Perciasepe, Dep. Adm'r, Env'tl. Prot. Agency, to Arthur Elkins, Inspector Gen., Env'tl. Prot. Agency (Feb. 27, 2014).

assertion ignores the fact that Dunham herself has personal knowledge of McCarthy's handling of the Beale matter and that Dunham refused to cooperate with the OIG on the Beale matter. Despite the claim of being unrelated to the Beale matter, it appears that the stand down letter is centrally related to the OIG's ability to obtain full information about the Beale matter. Further, it appears that McCarthy's letter shields Dunham from her obligation to cooperate with the OIG. Overall, Dunham's unwillingness to cooperate reveals a lack of transparency and accountability at the Agency as gaps in the story on Beale remain.

Concerns with Steve Williams and the Office of Homeland Security

The Committee has obtained evidence that suggests Steven Williams and other employees in EPA's Office of Homeland Security, a small office comprised of just five EPA officials, have potentially hindered investigations undertaken by the EPA OIG. On November 16, 2012, Nancy Dunham referred concerns over Beale's CIA status to Williams.²⁷ Despite the fact that Williams, pursuant to Intelligence Community Directive 304, should have already known whether or not Beale was jointly employed with the CIA, Williams reached out the CIA to determine whether or not Beale actually worked with an intelligence agency.²⁸ On November 26, 2012, Williams asked his colleague in OHS, John Martin, to contact the CIA regarding Beale's status.²⁹ The CIA informed Williams on December 3, 2012, that "CIA had no knowledge of a relationship or agreement with Mr. Beale" and "such a relationship was highly unlikely."³⁰

On December 12, 2012, Williams, along with Dunham, relayed this information to Gina McCarthy at an in-person meeting.³¹ The next day Williams met with Beale, but failed to challenge Beale's CIA claims.³² Rather, Williams sought "to reassure [Beale] ... that [his] offer was to help,"³³ and over the next two months as Beale deflected William's inquiries, no one at EPA pushed back on his claims.³⁴ In fact, it was not until June 2013 that Beale finally admitted he did not work for the CIA.³⁵ Thus, it appears that Williams not only "tipped off" Beale that the Agency was suspicious of his CIA identity, but his efforts appear to have delayed the OIG investigation, which could have aggravated Beale's fraud.

²⁷ Sworn Statement of Steve Williams at 2 (Mar. 29, 2013).

²⁸ *Id.* at 3.

²⁹ *Id.*

³⁰ *Id.*

³¹ *Id.*

³² *Id.*

³³ *Id.* at 4

³⁴ *Id.* at 4-5

³⁵ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale Before the H. Comm. On Oversight and Government Reform, 113th Cong. (Oct. 1, 2013) (Testimony of Patrick Sullivan, Office of Inspector Gen., Env'tl. Prot. Agency).*

Williams has also been at the center of recent disruptions to OIG investigations. It appears that Williams routinely “issued non-disclosure agreements to EPA employees that prevented these employees from cooperating with OIG investigations.”³⁶ Further, EPW Republicans have learned that on several occasions Williams’ interactions with OIG investigators have impeded the OIG from carrying out their responsibilities.³⁷ In one instance involving Williams and an OIG agent, Williams effectively caused an unnecessary delay as Administrator McCarthy subsequently put a hold on the OIG’s investigation.³⁸ Notably, John Martin, the OHS official who contacted the CIA regarding Beale on Williams’s behalf, was also involved in this incident. Specifically, the incident occurred as an OIG agent attempted to get Martin, to sign a customary non-disclosure form required of those interviewed in the course of an OIG investigation.³⁹ However, it appears no one has been held accountable for these issues. Indeed, following Administrator McCarthy’s stand down letter to the OIG and OHS, the Acting Associate Administrator for OHS, Juan Reyes, retired, thus excusing Mr. Reyes from subsequent OIG questioning.⁴⁰ Accordingly, it seems the OHS has continued to hinder transparency and a timely resolution of Agency investigations into potential misconduct.

Concerns with Office of Inspector General

Aside from the issues described in this memorandum, it is important to note that the OIG’s February 24, 2014, letter to Ranking Member Vitter included additional discrepancies. First, the statement that EPW Republican staff request for a January 12, 2011, memo to Gina McCarthy was simply an “oral” request that led to confusion is false. The request was submitted in writing and specifically identified by date and description the subsequently disclosed memo.⁴¹ Following the letter, OIG staff has apologized for this misunderstanding, but has failed to update their response letter.

Second, the OIG’s assertion that Inspector General Elkins never considered the Beale case a human resources matter appears to be an effort to parse words as the OIG notes from an

³⁶ Letter from Arthur Elkins, Inspector Gen., Evtl. Prot. Agency, to Hon. David Vitter, Ranking Member, S. Comm. on Env’t & Pub. Works at 5 (Feb. 24, 2014).

³⁷ *Id.*

³⁸ *Id.*

³⁹ Briefing by Office of Inspector Gen., Evtl. Prot. Agency, for Republican Staff, S. Comm. on Env’t & Public Works (Feb. 24, 2014).

⁴⁰ *Id.*

⁴¹ Email from Republican Staff, S. Comm. on Env’t & Public Works, to Staff, Office of Inspector Gen., Evtl. Prot. Agency (Dec. 13, 2013, 10:52 AM EST) (“...January 12, 2011 memorandum to Gina McCarthy advising that she stop Beale’s retention bonuses, as well as the emails referenced in the report”); Email from Republican Staff, S. Comm. on Env’t & Public Works, to Staff, Office of Inspector Gen., Evtl. Prot. Agency (Dec. 16, 2013, 11:47 AM EST) (“[T]he January 12, 2011, memorandum to Gina McCarthy was not included in the documents...”); Email from Staff, Office of Inspector Gen., Evtl. Prot. Agency, to Republican Staff, S. Comm. on Env’t & Public Works (Dec. 16, 2013, 11:56 AM EST) (“Auditor Bob Adachi has confirmed that there is not a memorandum of that date to Gina McCarthy”).

interview, to which IG Elkins attended, with Assistant Administrator for OARM, Craig Hooks, plainly stated that Elkins viewed the issue as an administrative matter:

Hooks mentioned that he had discussed the Beale matter and his involvement in the CIA with Arthur Elkins, EPA IG, after one of the Senior Staff meetings. Elkins mentioned that Hooks never mentioned anything about the CIA. Hooks corrected himself that he asked about any employee attendance matter and that Elkins told him that it seemed like an administrative matter that should be handled by Agency management. Elkins agreed with Hooks recollection (emphasis added).⁴²

Despite this account, OIG staff has asserted that Elkins could not remember such conversation, hinting that either Hooks' interview may not have been fully accurate or the OIG staff preparing the notes did not accurately record IG Elkins recollection of events.

Conclusion

These new facts further weaken the public narrative offered by the OIG and the EPA. Rather, they indicate that the public did not receive the full account of the case in an apparent effort to shield high ranking EPA officials from accountability. Accordingly, EPW Republicans will continue its investigation and probe for more information from the OIG and Agency to bring transparency to the biggest scandal at the EPA.

⁴² Interview Notes from Office of Inspector Gen., Env'tl. Prot. Agency, Interview with Craig Hooks at 2 (Nov. 14, 2013).

Senator VITTER. Thank you.

This memorandum exposes an indisputable time line that raises questions not just about John Beale, about EPA. In January 2011, Ms. McCarthy was informed that Beale had been receiving erroneous bonus payments that actually elevated his salary above a statutory cap, and was advised by her human resources staff and legal counsel to cancel the bonus. Instead, she deferred to an EPA official equal to her in rank at the time, allegedly because of uncertainty over Beale's CIA status. However, a senior EPA official directly informed Ms. McCarthy that there were no CIA employees at EPA.

While it appears Ms. McCarthy believed the matter was closed when Beale announced his retirement in May 2011, she learned in March 2012 that Beale had not retired and in fact collected full pay plus the illegal retention bonus of \$42,768. Ms. McCarthy took no action against Beale for nearly a year after this, finally canceling the illegal bonus in February 2013. And instead of firing Beale, Ms. McCarthy allowed him to retire 2 months later with full benefits.

Now, it is now clear that Beale also led one of EPA's most significant rulemakings prior to that, the 1997 National Ambient Air Quality Standards for Ozone and Particulate Matter. This effort codified EPA's practice of using fine particulates to inflate alleged benefits of nearly all Clean Air Act regulations. Almost two decades later, the Agency still refuses to share all the scientific data underpinning these very costly regulations.

Collectively, Beale and his best friend Robert Brenner's work on the standards introduced a series of dubious actions that the Agency has continued to follow and comprised what my committee staff has referred to as EPA's playbook, as detailed in a comprehensive staff report issued last week on this issue, and I would like to enter that into the record.

Senator BOXER. Without objection.

[The referenced documents follow:]

January 12, 2011

NOTE TO: Gina
THRU: Margaret
FROM: Scott *SPM*
RE: John Beale Retention Pay

John Beale has been receiving a retention bonus of 25% every year since 1991. EPA policy requires that OAR recertify the bonus annually and re-establish the bonus every three years. EPA has no records to show that these recertifications occurred except for one in 2000. Due to quirks in EPA's payroll system, the bonus was added to his pay automatically each year and went undetected until last summer.

We may pay a retention allowance to an employee based on either "unusually high or unique qualifications" or when there is a "special Agency need" to retain the employee's services, and in both cases the employee must be shown to be "likely to leave" (often involving a written offer of employment from outside EPA). John does not appear to meet the "special Agency need" or "likely to leave" criteria. OGC advised that EPA should not continue to pay the allowance if the criteria are not being met. OHR has told me they will not unilaterally cancel the allowance, and that a statement from OAR is necessary to cancel it.

I recommend that we act now to cancel the allowance, and that John be notified of the cancellation. There is a related issue, in that for at least the last three (possibly four) years John received total compensation in excess of a statutory limit, resulting in a total overpayment of approximately \$18,000. We are waiting for a complete analysis by OHR before EPA can determine how to resolve the overpayment with John. I expect that OARM will allow John to request a waiver of repayment. Although I cannot provide complete information about the overpayment at this time, it is nonetheless appropriate for us to tell John the overpayment has occurred.



Office of Inspector General

Administration Workpaper

Prepared by: Robert Adachi 11/18/2013

Assignment: 2013 - 3943 - OA-FY13-0396 - Congressional Request - Senator Vitter Request for Review of Agency Timekeeping
 Area: 5562
 Goal: Effective Management
 Type: PERFORMANCE/PROGRAM Subtype: Not Used
 Assignment Period: 09/11/2013 through 09/30/2014
 Section: E
 Assignment Guide Name: Agency Briefings/Required Meetings

Origination Doclink:

Subject: R-2 Gina McCarthy Interview - November 14, 2013

Subsection: 09

Information contained in this working paper and related attachments may be PII or CBI sensitive and should not be released without prior consent from the U.S. EPA Office of the Inspector General.

	Initials	Date	Comments
Preparer Initials/Date Completed	安達	11/18/2013	
1st Level Review	AMB	11/19/13	No Comments
2nd Level Review	LLN	11/25/13	No comments

Anchor links added 11/25/2013 and 11/26/2013. BS

PURPOSE: To document meeting held on November 14, 2013, @ 3:00pm EST with Gina McCarthy, EPA Administrator

IN ATTENDANCE: Gina McCarthy, EPA Administrator
 Kevin Minoli, EPA General Counsel
 Arthur Elkins, OIG
 Chuck Sheehan, DIG
 Richard Eyermann, Acting AIGA
 John Trefry, Deputy Director Forensic Audit Product Line
 Robert Adachi, Director Forensic Audit Product Line

SOURCE: Self-initiated

SCOPE: To obtain information in connection with McCarthy's role in John Beale matter

CONCLUSION:

1. McCarthy had concerns about Beale since the moment she was hired.

2. There was no documentation to support Beale's contention that he worked for the CIA.
3. McCarthy relied on Craig Hooks for advice on how to handle the situation but was advised by Hooks to "stand down" on the matter since it was a criminal matter and that Hooks would refer to the OIG.
4. McCarthy was not aware of recommendations made by OAR and OARM staff on how to resolve the retention bonus and statutory pay issues concerning Beale.

DETAILS:

1. McCarthy stated that she had concerns about John Beale from the moment she was hired as the AA-OAR. She was unable to verify the work that he was performing and Beale was spending less and less time in the office. McCarthy's said the Beale's attitude was that he was tired and that he planned to write a book about his experiences with the CIA. This was about 6-9 months after McCarthy was hired.
2. McCarthy thought that Beale was "goofing off". She talked to Beth Craig about how to handle the situation. McCarthy said that she did not know how the Federal system worked and that she had to rely on those that knew the Federal system. She talked to Craig Hooks and Nanci Gelb about the situation. She also asked Scott Fulton to see if there was any documentation available that would indicate that Beale was actually a CIA employee. However no documentation existed.
3. McCarthy felt that the Beale matter was not a high priority for Hooks. She got serious about the matter when she learned about Beale receiving a retention bonus. McCarthy never approved a retention bonus for Beale. She also wanted the CIA to pay for Beale's salary since Beale was not producing anything for EPA. McCarthy stated that there was no paperwork about Beale working for the CIA.
4. McCarthy said that Hooks was going to refer the Beale matter to the OIG. McCarthy stated that Hooks told her that he had talked to Arthur Elkins after a Senior Staff meeting and mentioned that it was a criminal matter involving a lack of attendance. She also said that she talked to Bob Perciasepe about the issue. McCarthy stated that she did not talk to anyone outside of EPA about the Beale matter.
5. McCarthy was shown a copy of the July 2010 report prepared by Susan Smith which outlined the problems concerning the retention bonus and statutory pay problems associated with Beale (see file below). The report also made five recommendations for action. McCarthy stated that she had never seen a copy of the report before.



Susan Smith Report.pdf



{In Archive} Re: OAR Issue
 Karen Higginbotham to: Susan Smith

02/01/2011 01:37 PM

History: This message has been replied to and forwarded.
 Archive: This message is being viewed in an archive.



beale2.docx

Craig asked to meet with Kim on this matter. Here is the briefing doc that Kim used in her meeting. Since Bob P signed the last retention bonus memo, it is my understanding that Craig was going to speak with him about this employee before advising OAR. I do not have a status for you on this. I will however, follow-up (again) with Shelandra on the final numbers.

Karen

Susan Smith Karen - Just wondering what the status of the J... 02/01/2011 01:09:00 PM

From: Susan Smith/DC/USEPA/US
 To: Karen Higginbotham/DC/USEPA/US@EPA
 Date: 02/01/2011 01:09 PM
 Subject: OAR Issue

Karen -

Just wondering what the status of the John Beale issue is. While I am still waiting for final overpayment numbers from QCFO, Scott Monroe stopped by today and said they had the paperwork requesting cancellation of the retention bonus ready to forward to OARM. However, he said that Gina is reluctant to finalize unless OARM (Craig) gives her the okay that the White House is aware and there will not be any political fallout. Apparently she talked to Craig several weeks ago. That was about the same time you picked up my package of Beale info and Susan K. called me asking questions about the issue.

Also, were you able to get a hold of Shelandra Burton regarding final overpayment #s for 2006 and 2010. Thanks!

Susan C. Smith, Team Leader
 U.S. Environmental Protection Agency
 Executive Resources Division/CHR/OARM
 Room 5521 Ariel Rios North, MC 3606A
 1200 Pennsylvania Ave. NW
 Washington, DC 20460
 202-564-6656
 202-564-3466 (fax)



Office of Inspector General

Administration Workpaper

Prepared by: Robert Adachi 11/18/2013

Assignment: 2013 - 3943 - OA-FY13-0396 - Congressional Request - Senator Vitter Request for Review of Agency Timekeeping
Area: 5582

Goal: Effective Management

Type: PERFORMANCE/PROGRAM Subtype: Not Used

Assignment Period: 09/11/2013 through 09/30/2014

Section: E

Assignment Guide Name: Agency Briefings/Required Meetings

Origination Doclink: [\[\]](#)

Subject: R-2 Bob Perciasepe Interview - November 15, 2013

Subsection: 11

Information contained in this working paper and related attachments may be PII or CBI sensitive and should not be released without prior consent from the U.S. EPA Office of the Inspector General.

	Initials	Date	Comments
Preparer Initials/Date Completed	安達	11/18/2013	
1st Level Review	AMB	11/19/13	See edits in pink font.
2nd Level Review	LLN	11/25/13	No comments.

Anchor links added 11/26/2013. BS

PURPOSE: To document meeting held on November 15, 2013, @ 3:00pm EST with Bob Perciasepe, EPA Deputy Administrator

IN ATTENDANCE: Bob Perciasepe, EPA Deputy Administrator
 Kevin Minoli, EPA General Counsel
 Arthur Elkins, OIG
 Chuck Sheehan, DIG
 Richard Eyer mann, Acting AIGA
 John Trefry, Deputy Director Forensic Audit Product Line
 Robert Adachi, Director Forensic Audit Product Line

SOURCE: Self-initiated

SCOPE: To obtain information in connection with Perciasepe's role in John Beale matter

CONCLUSION:

Perciasepe first became aware of problems with Beale in 2011 when Craig Hooks and Gina McCarthy asked whether Beale worked for the CIA.

Perciasepe thought the issue was a HR/personnel matter and asked OARM to handle the issue.

Perciasepe did not know why the matter was never resolved since there are no CIA employees working in EPA.

DETAILS:

At the beginning of the meeting, Perciasepe asked if he could get a summary of the work being done by the OIG, the types of products to be issued and estimated timeframes Adachi went over the two phases of the work being planned in the following areas: retention pay, statutory pay, time and attendance, the vetting process for new employees and travel. All areas but travel would be handled by Adachi's group. Travel would be handled by the Efficiency Audit Product Line managed by Mike Davis. Perciasepe was interested in the findings, the OIG would arrive at, particularly in the time and attendance area. Adachi mentioned the first product would be a Early Warning Briefing report to be issued to Senator David Vitter, who requested the audit. Perciasepe asked if the OIG issues reports directly to Congress. Adachi said that since the Senator requested the audit, the report would be addressed to him. Elkins also explained that the OIG does have a dual reporting responsibility to both the Agency and Congress. Adachi emphasized that the Agency would be given a briefing about the Early Warning report prior to its issuance to the Senator.

Perciasepe said that he first became aware of problems with John Beale in 2011 when Gina McCarthy and Craig Hooks came to him wondering whether Beale worked for the CIA. Perciasepe told McCarthy and Hooks that they needed to find out if it was true. Perciasepe did ask OARM to handle the matter since Perciasepe felt that this was an HR/personnel matter. For that reason, Perciasepe felt that there would have been no need to ask the OIG to look into the issue.

Perciasepe was shown a copy of the July 2010 report prepared by Susan Smith which outlined the problems concerning the retention bonus and statutory pay problems associated with Beale. The report also made five recommendations for action. Perciasepe stated that he had never seen the document before. Perciasepe mentioned that prior to the OIG involvement, the only issue he was aware of was whether John Beale worked for the CIA – He was not aware of the retention or pay issues until after the OIG was involved.



Susan Smith Report.pdf

Perciasepe was shown a copy of the email dated February 1, 2011 (see file below). Perciasepe had no comment on the email.



Beale Email.pdf

Perciasepe went over again that in early 2011, Hooks came by and asked if Beale worked for the CIA. McCarthy came by as well. As the Chief Operating Officer of EPA, Perciasepe felt it was important for Hooks to find out the status. Perciasepe said that there are no CIA employees working for EPA, so it was important to find out. Perciasepe mentioned that when he was the AA-OAR, Beale worked for him for one and half years in the 90's. Beale was responsible for daily meetings with the State Department on international affairs.

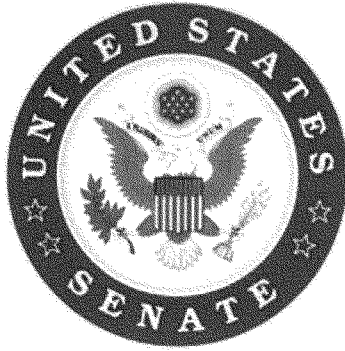
Perciasepe did not know why the matter did not get resolved since he thought it was an HR matter. It did not get resolved until it was referred to the OIG.

Status: In Progress Send To:
In Progress Edit Authorization: Angela Bennett/R4/USEPA/US, Bill Spinazzola/OIG/USEPA/US, Darren Schorer/R10/USEPA/US, Jean Bloom/R1/USEPA/US, John Trefry/OIG/USEPA/US, Kevin Christensen/OIG/USEPA/US, Kevin Collins/R3/USEPA/US, Leah Nikaidoh/Ci/USEPA/US, Lela Wong/OIG/USEPA/US, Richard Eyermann/OIG/USEPA/US, Robert Adachi/OIG/USEPA/US
Current Editor List: Angela Bennett/R4/USEPA/US, Bill Spinazzola/OIG/USEPA/US, Darren Schorer/R10/USEPA/US, Jean Bloom/R1/USEPA/US, John Trefry/OIG/USEPA/US, Kevin Christensen/OIG/USEPA/US, Kevin Collins/R3/USEPA/US, Leah Nikaidoh/Ci/USEPA/US, Lela Wong/OIG/USEPA/US, Richard Eyermann/OIG/USEPA/US, Robert Adachi/OIG/USEPA/US
Level 1 approval:
Level 2 approval:

History

**United States Senate
Committee on Environment and Public Works
Minority Staff Report**

EPA's Playbook Unveiled:



***A Story of Fraud, Deceit, and
Secret Science***

March 19, 2014

Contact: Luke Bolar — Luke_Bolar@epw.senate.gov (202) 224-6176
Cheyenne Steel — Cheyenne_Steel@epw.senate.gov (202) 224-6176
U.S. Senate Committee on Environment and Public Works (Minority)

EXECUTIVE SUMMARY

The greatness of our unique nation hinges on the fundamental purpose of the government to serve at the will of the people and to carry out public policy that is in the public interest. When it comes to the executive branch, the Courts have extended deference to agency policy decisions under the theory that our agencies are composed of neutral, non-biased, highly specialized public servants with particular knowledge about policy matters. This report will reveal that within the Environmental Protection Agency (EPA), some officials making critically important policy decisions were not remotely qualified, anything but neutral, and in at least one case — EPA decision making was delegated to a now convicted felon and con artist, John Beale.

John Beale is the character from the bizarre tale of the fake CIA agent who used his perch at the EPA to bilk the American taxpayer out of more than a million dollars. Even Jon Stewart, host of the popular Daily Show, featured Beale's bizarre tale as "Charlatan's Web" on his program in December 2013. Before his best friend Robert Brenner hired him to work at EPA, Beale had no legislative or environmental policy experience and wandered between jobs at a small-town law firm, a political campaign, and an apple farm. Yet at the time he was recruited to EPA, Brenner arranged to place him in the highest pay scale for general service employees, a post that typically is earned by those with significant experience.

What most Americans do not know is that Beale and Brenner were not obscure no-name bureaucrats housed in the bowels of the Agency. Through his position as head of the Office of Policy, Analysis, and Review, Brenner built a "fiefdom" that allowed him to insert himself into a number of important policy issues and to influence the direction of the Agency. Beale was one of Brenner's acolytes — who owed his career and hefty salary to his best friend.

During the Clinton Administration, Beale and Brenner were very powerful members of EPA's senior leadership team within the Office of Air and Radiation, the office responsible for issuing the most expensive and onerous federal regulations. Beale himself was the lead EPA official for one of the most controversial and far reaching regulations ever issued by the Agency, the 1997 National Ambient Air Quality Standards (NAAQS) for Ozone and Particulate Matter (PM). These standards marked a turning point for EPA air regulations and set the stage for the exponential growth of the Agency's power over the American economy. Delegating the NAAQS to Beale was the result of Brenner's facilitating the confidence of EPA elites, making Beale the gatekeeper for critical information throughout the process. Beale accomplished this coup based on his charisma and steadfast application of the belief that the ends justify the means.

Concerned about this connection, the Senate Committee on Environment and Public Works (EPW) staff have learned that the same mind that concocted a myriad of ways to abuse the trust of his EPA supervisors while committing fraud is the same mind that abused the deference afforded to public servants when he led EPA's effort on the 1997 NAAQS.

Brenner was known to have an objective on NAAQS, and would have done whatever was necessary to accomplish his desired outcome. Together, Brenner and Beale implemented a plan, which this report refers to as "EPA's Playbook." The Playbook includes several tools first employed in the 1997 process, including sue-and-settle arrangements with a friendly outside

group, manipulation of science, incomplete cost-benefit analysis reviews, heavy-handed management of interagency review processes, and capitalizing on information asymmetry, reinforced by resistance to transparency. Ultimately, the guiding principal behind the Playbook is the Machiavellian principal that the ends will justify the means.

In the case of the 1997 NAAQS, the Playbook started with a sue-and-settle agreement with the American Lung Association, which established a compressed timeline to draft and issue PM standards. This timeline was further compressed when EPA made the unprecedented decision to simultaneously issue new standards for both PM and Ozone. Issuing these standards in tandem and under the pressure of the sue-and-settle deadline, Beale had the mechanism he needed to ignore opposition to the standards — EPA simply did not have the time to consider dissenting opinions.

The techniques of the Playbook were on full display in the “Beale Memo,” a confidential document that was leaked to Congress during the controversy, which revealed how he pressured the Office of Information and Regulatory Affairs to back off its criticism of the NAAQS and forced them to alter their response to Congress in 1997. EPA also brushed aside objections raised by Congress, the Office of Management and Budget, the Department of Energy, the White House Council of Economic Advisors, the White House Office of Science and Technology Policy, the National Academy of Sciences, and EPA’s own scientific advisers — the Clean Air Science Advisory Committee.

These circumstances were compounded by EPA’s “policy call” to regulate PM_{2.5} for the first time in 1997. PM_{2.5} are ubiquitous tiny particles, the reduction of which EPA used to support both the PM and Ozone NAAQS. In doing so, the Playbook also addressed Beale’s approach to EPA’s economic analysis: overstate the benefits and underrepresent the costs of federal regulations. This technique has been applied over the years and burdens the American people today, as up to 80% of the benefits associated with all federal regulations are attributed to supposed PM_{2.5} reductions.

EPA has also manipulated the use of PM_{2.5} through the NAAQS process as the proffered health effects attributable to PM_{2.5} have never been independently verified. In the 1997 PM NAAQS, EPA justified the critical standards on only two data sets, the Harvard “Six Cities” and American Cancer Society (ACS II) studies. At the time, the underlying data for the studies were over a decade old and were vulnerable to even the most basic scrutiny. Yet the use of such weak studies reveals another lesson from EPA’s Playbook: shield the underlying data from scrutiny.

Since the 1997 standards were issued, EPA has steadfastly refused to facilitate independent analysis of the studies upon which the benefits claimed were based. While this is alarming in and of itself, this report also reveals that the EPA has continued to rely upon the secret science within the same two studies to justify the vast majority of all Clean Air Act regulations issued to this day. In manipulating the scientific process, Beale effectively closed the door to open scientific enquiry, a practice the Agency has followed ever since. Even after the passage in 1999 of the Shelby Amendment, a legislative response to EPA’s secret science that requires access to federal scientific data, and President Obama’s Executive Orders on

Transparency and Data Access, the EPA continues to withhold the underlying data that originally supported Beale's efforts.

After President Clinton endorsed the 1997 NAAQS and the Agency celebrated their finalization, Beale became immune to scrutiny or the obligation to be productive for the remainder of his time at the Agency. Similarly, the product of his labors have remained intact and have been shielded from any meaningful scrutiny, much the same way Beale was protected by an inner circle of career staff who unwittingly aided in his fraud. Accordingly, it appears that the Agency is content to let the American people pay the price for Beale and EPA's scientific insularity, a price EPA is still trying to hide almost twenty years later.

After reaching the pinnacle of his career at the Agency in 1997, and facing no accountability thereafter, Beale put matters on cruise control and enjoyed the lavish lifestyle that the highest paid EPA employee could afford, producing virtually no substantive work product thereafter. For Beale's successes in the 1997 NAAQS process, Beale was idolized as a hero at the Agency. According to current EPA Administrator, Gina McCarthy, "John Beale walked on water at EPA." This unusual culture of idolatry has led EPA officials to blind themselves to Beale's wrongdoing and caused them to neglect their duty to act as public servants. As such, to this day EPA continues to protect Beale's work product and the secret science behind the Agency's NAAQS and PM claims.

FINDINGS

- After Robert Brenner assumed the position of Deputy Director of Office of Policy, Analysis, and Review (OPAR), within the office of Air and Radiation, (OAR) in 1988, he recruited John Beale to work for him in OPAR, and arranged to pay his friend the highest step on the General Service pay scale, despite the fact that Beale had no prior government experience.
- Brenner's decision to hire Beale was based solely on their personal relationship and not on Beale's qualifications. Beale himself admitted that he had no environmental experience. In the critical area of federal legislative experience, Beale's supposed qualification was an unpaid undergraduate internship for Senator John Tunney (D-CA).
- In 1994, Beale started spreading his most notorious lie, that he was an operative for the CIA. Apparently the lie began as a joke by Beale's coworkers, which Beale then seized upon and spun into a full blown false identity.
- At the same time, under Beale and Brenner's control, OPAR grew in both scope and influence, stretching the boundaries of OPAR's authority. According to a former high ranking official, OPAR was Brenner's "fiefdom" where he was considered to be "the most influential career person at [the] Agency [as] head of OPAR."
- Beginning in 1995, Beale and Brenner took the lead on EPA's internal process to set National Ambient Air Quality Standards (NAAQS) for Ozone and Particulate Matter (PM). The duo set in motion "EPA's Playbook," a strategy to game the system by compressing the Office of Information and Regulatory Affairs (OIRA) review via a friendly sue-and-settle arrangement, relying on secret science, and inflating benefits while underestimating costs.
- Evidence suggests that Beale used the NAAQS as a vehicle for his own self-aggrandizement and rose above reporting just to Brenner and began to work alongside Mary Nichols, the Assistant Administrator (AA) for OAR at the time, as well as then-Administrator Carol Browner.
- With these standards, EPA sought to regulate fine particulates (PM_{2.5}) in addition to larger particles (PM₁₀) for the first time under the NAAQS, despite a distinct lack of scientific understanding of the integrity of the underlying data.
- The two studies EPA relied upon, known as the Harvard "Six Cities" and American Cancer Society (ACS II) studies, were and remain controversial. EPA's own scientific advisors warned EPA that the Six Cities study was "not in the peer-reviewed literature" and emphasized that there were significant uncertainties with the data, meaning EPA's decision to proceed with the standards was a pure "policy call."

- Both Administrator Carol Browner and AA Mary Nichols admitted that neither of them had actually read the studies. Rather, it appears that Browner and Nichols deferred to the “expertise” of EPA’s career staff — Beale and Brenner — to make this “policy call.”
- Beale led EPA’s effort to suppress interagency criticism of the standards and issued the “Beale Memo,” threatening OIRA officials who dared to criticize EPA in a letter to Congress. EPA tried to hide the existence of the Beale Memo from Congress, but was undermined by a conscientious whistleblower who surreptitiously turned over the memo to Congressional staff.
- Beale used his leadership on the 1997 Ozone and PM NAAQS as a justification for nearly all of his monetary awards. At the end of the Clinton Administration, Brenner pushed through a renewal of Beale’s retention incentive bonus and recommended him for a promotion to Senior Leader. This made Beale one of the highest paid, non-elected federal government employees. He also used his work on the 1997 NAAQS as the foundation necessary to secure his colleagues’ confidence, which paved the way for his future lies and abuse of his leadership position at the Agency.
- When current Administrator Gina McCarthy was Beale’s supervisor, she was reportedly very impressed with Beale’s intelligence and leadership ability when she moved him in 2010 to be the immediate office’s lead for all of OAR’s international work.
- In 2010, Brenner accepted an illegal gift from his golfing buddy, prominent DC attorney, and member of the Clean Air Act Advisory Committee, Pat Rahe; but retired in August 2011, before the Agency could take administrative action against him and the EPA Office of Inspector General (OIG) could question him on the matter.
- Beale stopped showing up to work at EPA in June 2011; however, he never filed his retirement paperwork. His ability to continue to collect his salary without doing any work for EPA was facilitated by an arrangement he made with McCarthy before he left the Agency, as he had no set termination date. In December 2012, McCarthy met with Beale for the first time in nearly fifteen months, and he informed her that he was no longer planning on retiring. Two more months passed before concerns with Beale were officially reported to the OIG.
- On March 4, 2013, President Barack Obama nominated McCarthy to replace Lisa Jackson as head of the EPA. EPW Republicans made transparency, including data access, a priority throughout her confirmation process. Specifically, EPW Republicans sought the Agency’s secret science used to justify nearly all regulations issued under the Clean Air Act. This underlying science is the exact same science that Beale relied on in setting the 1997 PM NAAQS.
- On April 30, 2013, McCarthy had cause to fire Beale, but instead elected to allow him to voluntarily retire with full benefits.

- On July 9, 2013, the EPA finally agreed to initiate the process of acquiring and turning over the secret data to EPW Republicans. On July 18, 2013, McCarthy was sworn in to be the next Administrator of EPA. On August 21, 2013, pursuant to the agreement regarding McCarthy's confirmation, EPW Republicans received the first tranche of scientific data.
- On August 23, 2013, the Department of Justice filed criminal charges against John Beale and on September 27, 2013, Beale pled guilty to government theft of nearly \$900,000, pursuant to a plea agreement covering Beale's crimes from 2000 to 2013.
- Several of Beale's former colleagues submitted letters to the court requesting leniency in Beale's sentencing, including one key official from the 1997 NAAQS, Lydia Wegman. These officials' reaction to the scandal suggests that an individual can steal a million dollars from taxpayers and perpetrate a crime for nearly two decades, but still be considered — by some — as an environmental legend.
- On December 18, 2013, Beale was sentenced to 32 months in federal prison. Even after his voluntary confession and subsequent conviction, many of his former colleagues refuse to view him as a criminal. Some at EPA have clung to the narrative that Beale was CIA, and believe that Beale was being abandoned by his former agency.
- On March 11, 2014, Senator Vitter sent a letter to the EPA inquiring where they were in the process of being able to de-identify the datasets, a necessary step to making the data accessible for independent reanalysis.
- On March 17, 2014, Senator Vitter sent a letter to Dr. Francesca Grifo, EPA's Scientific Integrity Official, regarding concerns with EPA continuing to violate the Organization for Co-operation and Economic Development's (OECD) guidelines for "Best Practices for Ensuring Scientific Integrity and Preventing Misconduct." The letter focused on data-related misconduct ("not preserving primary data," "bad data management, storage," "withholding data from the scientific community") and outlining the serious concern that Harvard, American Cancer Society, the researchers, and the EPA were likely responsible for similar data-related misconduct as an OECD member country.

Contents

INTRODUCTION	1
I. WHERE IT BEGINS: Origin of an Alliance	2
a. A Friendship for Life.....	2
b. Establishing a Partnership at EPA	5
II. GAMING THE SYSTEM: Fooling EPA and the Public	7
a. Clinton Years: Creating an Infrastructure for Long-Term Abuse.....	7
b. George W. Bush Years: Waning Influence and Testing Patience	11
c. Obama Administration: Pinnacle of Fraud.....	14
d. The Escape Plan: Joint “Retirement”.....	16
III. ESTABLISHING EPA’S PLAYBOOK: BEALE AND 1997 NAAQS	20
a. Beale and Brenner’s Tentacles Through EPA	20
b. 1997 NAAQS Made Beale an EPA Legend	23
i. Beale’s PM _{2.5} “Policy Choice” Made History	25
ii. Beale Practices Damage Control over PM and Ozone NAAQS	35
c. A Sustainable Strategy: Beale and Secret Science Above Reproach.....	39
i. EPA Shielded the Secret Science.....	39
ii. Beale Made Friends in the Right Places During NAAQS	41
iii. Beale Used NAAQS to Advance Fraud	43
IV. SECRET AGENT AND SECRET SCIENCE: Still Plaguuing Americans .45	
a. Inflated PM _{2.5} Benefits Provide Cover for EPA’s Regulatory Agenda	46
b. EPA Continues to Shield Secret Science.....	50
c. Congress Fights for Transparency and Access to Secret Science.....	53
CONCLUSION	58

INTRODUCTION

The actions of John C. Beale, a former senior official at the U.S. Environmental Protection Agency (EPA) who claimed to be a CIA agent for years and was later convicted of fraud and stealing nearly \$900,000 from American taxpayers, have disgraced the Agency and raised questions about the integrity of the Agency's management and oversight abilities. In addition to investigating EPA's incompetence in the Beale saga, the Senate Committee on Environment and Public Works (EPW) staff has examined the ripple effects of Beale's tenure with the Agency. More specifically, staff has determined that Beale played a leading role in shaping some of our nation's most significant air regulations.

During the 1990s, Beale was instrumental in creating and implementing major regulations pursuant to the Clean Air Act (CAA), which have shaped the nation's most expansive and overreaching environmental efforts for nearly two decades. Unambiguously, Beale spearheaded the National Ambient Air Quality Standards (NAAQS) for Ozone and Particulate Matter (PM) in 1997, which were justified using data from two controversial studies that EPA has refused to share with Congress and the American public. These standards have affected all aspects of the U.S. economy, with a profound impact looming on Americans' utility costs.

Working with Beale through the years was his self-described best friend Robert Brenner, former Director of the Office of Policy, Analysis, and Review (OPAR) within the Office of Air and Radiation (OAR), who recruited Beale to EPA. Evidence suggests that Brenner played a pivotal role in Beale's fraud. Additionally, for over a decade the two developed controversial regulations under the CAA, establishing what this report refers to as "EPA's Playbook" by which EPA would expand and exacerbate its control over the U.S. economy. As the two men prepared to jointly retire in 2011, Brenner highlighted their unique relationship and described Beale's influence in shaping EPA's regulatory agenda:

I wanted to tell you what I should have said last night: it's no coincidence that OAR's greatest legislative, regulatory and international successes came when you were around to develop the strategy and make sure we all did our jobs in carrying it out. There is just no one better at it than you.

Back in '88, I thought I'd get to spend 2 or 3 years working with you on a pretty cool political/policy project. I still can't believe it turned into 23 years of working with my best friend to try to make some good things happen--I lucked out.¹

This report will detail the history of Beale and Brenner's personal and working relationship, how this relationship contributed to the most significant scandal in EPA history, and how these two individuals were at the heart of constructing a heavy-handed regulatory agenda with long-lasting and economically devastating effects.

¹ E-mail from John Beale to Robert Brenner (June 2, 2011, 06:36 EST) (*emphasis added*).

I. WHERE IT BEGINS: Origin of an Alliance

Before Robert Brenner recruited John Beale to work at EPA, Beale's professional life consisted of a string of random employers with no clear career trajectory. This made Beale neither an expert in public policy nor an expert in environmental law; his employment at EPA was solely based on his relationship with Brenner, whom he met while studying together at Princeton in the 1970s. Beale's abnormally high starting salary was not merit-based and certainly not supported by his resume; instead it was the product of Brenner's influence at the Agency. The relationship they shared was mutually beneficial, but Beale particularly capitalized on the opportunities as the growing stature of both men facilitated Beale's fraud over the next two decades.

a. A Friendship for Life

*"[W]hen the opportunity arose to help develop the new Clean Air Act, I was able to convince my best friend from those days, John Beale . . . to join me in the effort."*²

– Former Deputy Assistant Administrator, Office of Air and Radiation, Robert Brenner

In the years before he joined the EPA, Beale led an admittedly "itinerant" life and career.³ After dropping out of college,⁴ Beale allegedly served as a police officer in Costa Mesa, California,⁵ a position in which he later claimed that he worked undercover.⁶ Beale was drafted soon thereafter and served in the Army stateside as a physical therapist,⁷ but he left the service after completing the minimum amount of time required by law.⁸ Taking advantage of GI Bill benefits, Beale went back to school to finish his undergraduate degree,⁹ and then pursued a Master in Public Affairs at Princeton University.¹⁰

At Princeton, Beale and Robert Brenner met as classmates in 1975.¹¹ At graduate school, the two became best friends.¹² After each graduated with a Master in Public Affairs,¹³ the two

² Robert Brenner Graduate Alumni Profile, PRINCETON UNIVERSITY WOODROW WILSON SCHOOL OF PUBLIC AFFAIRS, <http://www.princeton.edu/qzalumni/testimonials/brenner/> (last visited Sept. 9, 2013) [hereinafter *Brenner 2013 Graduate Alumni Profile*] (on file with Committee).

³ Sentencing Memorandum of John C. Beale at 6, United States v. Beale, No. 1:13-cr-00247-ESH (D.D.C. Sept. 27, 2013).

⁴ *Id.* at 3.

⁵ *Id.*

⁶ John C. Beale, Application for Vacancy Announcement Number EPA-00-SL-OAR-6174 (Apr. 13, 2000) [hereinafter *Beale Senior Leader Application*].

⁷ Transcript of John C. Beale Deposition at 123–24, H. Comm. on Oversight & Gov't Reform, 113th Cong. (Dec. 19, 2013) [hereinafter *Transcript of John C. Beale Deposition*], available at <http://oversight.house.gov/wp-content/uploads/2014/01/Beale-Deposition.pdf>.

⁸ *Id.*

⁹ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 3.

¹⁰ See *id.* at 4.

¹¹ *Secret Agent Man? Oversight of EPA's IG Investigation of John Beale: Hearing Before the H. Comm. on Oversight & Gov't Reform*, 113th Cong. (Oct. 1, 2013) [hereinafter *Oversight & Gov't Reform Hearing*] (testimony of Robert Brenner)

stayed very close even as Brenner remained at Princeton's Center for International Studies¹⁴ and Beale pursued a law degree.¹⁵

In 1979, Brenner left Princeton to accept employment with the EPA.¹⁶ That same year, Beale graduated from law school and went to work in corporate law for the Seattle, Washington, office of the law firm Preston, Thorgrimson, Ellis, Holeman & Fletcher.¹⁷ Beale failed the Washington state bar exam on his first attempt, so he was not a practicing attorney for the firm.¹⁸ Thereafter, Beale joined the ultimately unsuccessful 1980 reelection campaign for Senator Warren Magnuson (D-CA).¹⁹ According to Beale, his decision to focus on the political campaign and his corresponding lack of focus on his studies for his second attempt at the Washington bar exam, ultimately led the firm to terminate his employment after only eighteen months.²⁰ Beale was subsequently given a job at his cousin's apple farm, where he worked for the next two-and-a-half years.²¹ After passing the bar exam in 1982,²² Beale eventually practiced law in the small town of Lake City, Minnesota, "represent[ing] clients in local matters, ranging from general business transactions to child protection cases," until Brenner recruited Beale to work at EPA in the fall of 1987.²³

Over the course of Beale's "nomadic" post-graduate work experience,²⁴ he and Brenner maintained close contact. In 1983, Beale and Brenner purchased a two-bedroom house on 2.14 acres in Truro, Massachusetts from Beale's parents.²⁵ The home had been in the Beale family since the 1960s.²⁶ At the time Beale and Brenner purchased the home, which was valued at approximately \$120,000,²⁷ Brenner invested \$10,000 in the property.²⁸ According to Brenner, from the early 1980s until about 1989, they saw each other roughly once a year at the vacation home.²⁹

¹² *Brenner 2013 Alumni Profile*, *supra* note 2.

¹³ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 4; *Alumnus Profile: Robert Brenner*, PRINCETON UNIVERSITY WOODROW WILSON SCHOOL OF PUBLIC & INTERNATIONAL AFFAIRS, <http://www.princeton.edu/alumni/stay-connected/what-alumni-are-up-to/brenner-robert> (last visited Jan. 29, 2014) [hereinafter *2014 Brenner Alumnus Profile*].

¹⁴ See *2014 Brenner Alumnus Profile*, *supra* note 13.

¹⁵ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 4.

¹⁶ See *2014 Brenner Alumnus Profile*, *supra* note 13.

¹⁷ See Deposition of John C. Beale, *supra* note 7, at 54.

¹⁸ See *id.* at 54–55.

¹⁹ See Deposition of John C. Beale, *supra* note 7, at 54–55.

²⁰ See *id.*

²¹ Sentencing Memorandum of John C. Beale, *supra* note 3, at 4.

²² *Lawyer Details*, MINNESOTA JUDICIAL BRANCH, <http://mncourts.gov/mars/AttorneyDetail.aspx?attyID=013904X> (last visited Jan 29, 2014) (confirming that Beale was admitted on Oct. 15, 1982). *But see* Beale Senior Leader Application, *supra* note 6 (asserting that Beale was barred in 1987).

²³ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 4.

²⁴ Deposition of John C. Beale, *supra* note 7, at 12.

²⁵ Search for Property Records of John C. Beale (LEXIS); see also *Search for Property Records of John C. Beale*, MASSACHUSETTS LAND RECORDS, <http://www.masslandrecords.com>.

²⁶ Oversight & Gov't Reform Hearing, *supra* note 11 (testimony of Robert Brenner).

²⁷ See Deposition of John C. Beale, *supra* note 7, at 31–32.

²⁸ Oversight & Gov't Reform Hearing, *supra* note 11 (testimony of Robert Brenner).

²⁹ *Id.*

In the fall of 1987, Beale and Brenner engaged in “several discussions about working together.”³⁰ When Brenner was promoted to Deputy Director of the Office of Policy, Analysis, and Review (OPAR),³¹ he used his new authority to land his struggling friend a position at the EPA.³² By December of that year, Beale had quit his job in Minnesota and moved to the Washington, D.C. area to work as a temporary consultant for OPAR.³³ In June 1989, Brenner hired Beale as “a permanent, career EPA employee with the position of Policy Analyst in OPAR.”³⁴ At the time, Brenner prepared an “Advance in Hire” memorandum that alleged Beale would not accept the position unless he started as a GS-15 Step 10³⁵ — the maximum pay level for federal general service employees.³⁶ Notably, individuals hired at GS-12 or above generally have at least twenty years of work experience,³⁷ so Beale’s hiring was an anomaly given his minimal experience.

It is extremely rare for a new employee to start at Beale’s pay level, an anomaly only compounded by his lack of pertinent experience.

Brenner has claimed he sought out Beale to help him shepherd legislation through Congress after EPA failed to push forward legislation to amend the Clean Air Act.³⁸ Rather than recruit someone with the requisite experience, Brenner sought out Beale, in what appears to be a decision based solely on their personal relationship, rather than any experience or credentials that would justify hiring Beale. On the central qualification identified by Brenner — experience in environmental policy — Beale himself admitted that he had no experience in the area.³⁹ In the critical area of federal legislative experience, Beale’s supposed qualification was limited to his alleged employment in the Washington, D.C., office of Senator John V. Tunney (D-CA).⁴⁰ However, the EPA Office of Inspector General (OIG) uncovered that Beale was never actually employed by Senator Tunney;⁴¹ he was only an unpaid undergraduate intern for a few months.⁴²

³⁰ *Id.* (statement of Robert Brenner).

³¹ Deposition of John C. Beale, *supra* note 7, at 14–15.

³² Sentencing Memorandum of John C. Beale, *supra* note 3, at 4

³³ *Id.*

³⁴ *Id.* at 7. Nevertheless, the OIG asserts that Beale was hired as a Senior Policy Advisor. *See Oversight & Gov’t Reform Hearing, supra* note 11 (statement of Patrick Sullivan).

³⁵ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

³⁶ *See Rates of Pay Under the General Schedule Effective the first pay period beginning on or after January 1, 1989, Office of Personnel Mgmt., available at http://archive.opm.gov/oca/pre1994/1989_Jan_GS.pdf.*

³⁷ *See U.S. MERIT SYSTEMS PROTECTIONS BOARD, IN SEARCH OF HIGHLY SKILLED WORKERS: A STUDY ON THE HIRING OF UPPER LEVEL EMPLOYEES FROM OUTSIDE THE FEDERAL GOVERNMENT 13 (2008), available at <http://www.mspb.gov/netsearch/viewdocs.aspx?docnumber=323118&version=323564&application=ACROBAT>.*

³⁸ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Robert Brenner).

³⁹ Deposition of John C. Beale, *supra* note 7, at 13 (demonstrating that Beale answered “no” when questioned as to whether he “ha[d] any environmental experience prior to joining the EPA”).

⁴⁰ Sentencing Memorandum of John C. Beale, *supra* note 3, at 3 n.1.

⁴¹ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁴² Sentencing Memorandum of John C. Beale, *supra* note 3, at 3 n.1.

b. Establishing a Partnership at EPA

“I still can’t believe it turned into 23 years of working with my best friend to try to make some good things happen—I lucked out.”⁴³

– Email from Robert Brenner to John Beale

Beale and Brenner remained close friends throughout nearly twenty-five years of working together at EPA. For the first decade of Beale’s EPA career, Brenner served as Beale’s supervisor.⁴⁴

When Beale first moved to the Washington, D.C. area to start work at the EPA, he lived in the same apartment complex as Brenner.⁴⁵ Moreover, during the first few years Beale worked for Brenner, they vacationed together regularly at the Cape Cod beach house they co-owned.⁴⁶ Even after several years of employment at the EPA, Beale lived in Brenner’s home for more than a full year during the mid-1990s.⁴⁷ In 1999, after fifteen years of jointly owning the vacation home in Cape Code, Beale purchased Brenner’s share of the home at a value of roughly \$40,000, four times the amount Brenner originally paid for it.⁴⁸ When this transaction occurred, Beale was Brenner’s subordinate. Less than a year later Brenner recommended Beale’s promotion to Senior Leader (SL) status, which essentially made him Brenner’s professional equivalent.

Among their coworkers, Brenner and Beale were known to “spen[d] a lot of time together outside of work: going out to eat, playing golf and going on vacations together.”⁴⁹ They also scheduled regular breakfasts and lunches that continued through the end of their tenures at EPA.⁵⁰ Moreover, Beale, Brenner, and their respective wives socialized frequently, arranging get-togethers ranging from frequent dinners⁵¹ to Valentine’s Day celebrations⁵² to volunteering

⁴³ E-mail from John Beale to Robert Brenner (June 2, 2011, 06:36 EST) (on file with Committee).

⁴⁴ See Letter from Justin Shur, Counsel to Robert Brenner, to Rep. Staff, S. Comm. on Env’t & Pub. Works (Oct. 4, 2013) [hereinafter Initial Letter from Justin Shur].

⁴⁵ See Search for Property Records of John C. Beale (LEXIS); Search for Property Records of Robert Brenner (LEXIS).

⁴⁶ Oversight & Gov’t Reform Hearing, *supra* note 11 (testimony of Robert Brenner).

⁴⁷ See Search for Property Records of John C. Beale (LEXIS); Search for Property Records of Robert Brenner (LEXIS).

⁴⁸ Oversight & Gov’t Reform Hearing, *supra* note 11 (testimony of Robert Brenner).

⁴⁹ See Memorandum of Interview of Addie Johnson from Office of Inspector Gen., Envtl. Prot. Agency 3 (Apr. 10, 2013) (on file with Committee).

⁵⁰ See, e.g., E-mail from John Beale to Robert Brenner (Apr. 7, 2012, 10:01 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Feb. 14, 2012, 12:32 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Jan. 25, 2012, 04:22 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Apr. 7, 2012, 10:01 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Nov. 5, 2011, 08:51 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Oct. 29, 2008, 02:41 EST).

⁵¹ See, e.g., E-mail from John Beale to Robert Brenner (Dec. 16, 2011, 11:35 EST) (on file with Committee); E-mail from Robert Brenner to John Beale (Nov. 6, 2008, 10:02 EST); E-mail from Robert Brenner to John Beale (Sept. 25, 2008, 14:08 EST) (on file with Committee); E-mail from Robert Brenner to John Beale (July 20, 2008, 01:49 EST) (on file with Committee); E-mail from Barbara Brenner to John Beale (Nov. 29, 2007, 14:49 EST) (on file with Committee); E-mail from John Beale to Robert Brenner (Nov. 6, 2006, 09:27 EST) (on file with Committee).

⁵² See E-mail from John Beale to Robert Brenner (Feb. 14, 2012, 12:32 EST) (on file with Committee).

for the Obama presidential campaign.⁵³ After working at the EPA together for more than two decades, the two planned a joint retirement party in September 2011,⁵⁴ which was paid for on Brenner's wife's credit card.⁵⁵

Beale and Brenner's friendship flourished as their careers increasingly overlapped. Such an arrangement proved to be mutually beneficial for the two of them. It is difficult to imagine that Beale could have gotten away with his long-term fraud against the Agency without the knowledge and support of his best friend Brenner. It is just as difficult to imagine Brenner's success at EPA without a cadre of followers who, like Beale, owed their career to Brenner.



Photo of Robert Brenner (left) and John Beale (right) before the House Committee on Oversight and Government Reform (October 1, 2013).

⁵³ See E-mail from Nancy Kete to Robert Brenner, John Beale, & Barbara Brenner (Nov. 4, 2008, 11:30 EST) (on file with Committee).

⁵⁴ Oversight & Gov't Reform Hearing, *supra* note 11 (testimony of Robert Brenner).

⁵⁵ See E-mail from Staff, Office of Inspector Gen., Envtl. Prot. Agency, to Rep. Staff, S. Comm. on Env't & Pub. Works (Nov. 15, 2013, 14:08 EST) (on file with Committee).

II. GAMING THE SYSTEM: Fooling EPA and the Public

While Brenner served as Beale's facilitator throughout his time at EPA, Beale developed alliances with certain colleagues to shield him from scrutiny as he perpetuated his expanding fraud. For example, Brenner recommended Beale for his retention incentive bonuses, several awards, and promotions while former Assistant Administrator (AA) for the Office of Air and Radiation (OAR), Bob Perciasepe, approved Beale's bonus and promotion in 2000. In addition, as Beth Craig, Deputy AA for OAR, grew close to Beale, she approved his excessive travel vouchers without confirming their integrity. During the Obama Administration, Beale's allies had renewed influence and Beale's manipulation expanded, allowing him to escape work for over a year and a half, yet still receive an EPA paycheck.

a. Clinton Years: Creating an Infrastructure for Long-Term Abuse

"It is important to understand that everything was collaborated by Robert Brenner about John Beale. When she had asked Mr. Brenner questions about Mr. Beale's attendance and health, she would be told that John will be in tomorrow....he is feeling better."⁵⁶

- Former Deputy Assistant Administrator, Office of Air and Radiation, Beth Craig

In 1991, near the end of the first Bush Administration, Beale claimed the title of Deputy Director for OPAR.⁵⁷ The same year, Brenner submitted a request for Beale to receive a Retention Incentive Bonus,⁵⁸ "a rare privilege, normally reserved for scientists and others with hard-to-come-by technical skills."⁵⁹ At EPA, a retention bonus can be worth up to 25% of an employee's base pay. A supervisor must recertify annually that the conditions justifying the bonus still exist, and are limited to a maximum duration of three years.⁶⁰ These certifications occurred in 1992 and 1993; however, no such certifications were made for the remainder of the Clinton Administration.⁶¹ Regardless, Beale's retention incentive bonus should have been terminated no later than 1994, yet it continued uninterrupted through 2000.⁶²

At some point in the early 1990s, after he began receiving bonus payments, Beale started to miss work allegedly due to the fact "that he had contracted malaria in Vietnam during service in the U.S. Army."⁶³ Beale neither served in Vietnam nor contracted malaria,⁶⁴ both of which

⁵⁶ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen., Evtl. Prot. Agency (Nov. 12, 2013) (on file with Committee).

⁵⁷ See Robert Brenner & John Beale, *Pizza at Midnight*, EPA JOURNAL, Jan.-Feb. 1991, at 54, 54.

⁵⁸ Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁵⁹ Michael Gaynor, *The Suit Who Spooked the EPA*, WASHINGTONIAN, Mar. 4, 2013,

<http://www.washingtonian.com/articles/people/the-suit-who-spooked-the-epa/>.

⁶⁰ *Id.*

⁶¹ Memorandum from Susan Smith, Team Leader, Executive Resource Division, Office of Admin. & Res. Mgmt., Evtl. Prot. Agency, Executive Overview/Analysis of J. Beale Pay Issues 2 (Mar. 14, 2013) (on file with Committee).

⁶² Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁶³ *Id.* The investigations by the OIG and Department of Justice did not include absences attributed to malaria in its calculations of Beale's time fraud, so the amount of money Beale pled guilty to stealing in his plea agreement is a vast understatement.

would have been documented on his military service record. No such documentation existed. The latter excuse, contracting malaria, is one he would use to hide from Congressional scrutiny on important scientific and policy matters. According to Beale, no one at EPA “ever ask[ed] . . . the sort of detailed questions about that claim or question[ed] the veracity of it,” nor “did anyone ever question [his] Vietnam service,” “ask[] for any documentation of the fact that [he] had malaria,” nor “ever ask what negative effects the malaria ha[d] on [his] day-to-day life.”⁶⁵ This willful ignorance occurred in a workplace where Beale was well-known for his athletic hobbies.⁶⁶ No one at the EPA was more knowledgeable of Beale’s active lifestyle than his supervisor and best friend, Brenner, as they were known to regularly engage in sporting activities together.⁶⁷ Despite Beale’s periodic time away from the office, he was promoted to Senior Policy Analyst in January 1994.⁶⁸ This coincided with Brenner’s promotion to the operational title of Deputy AA for OAR.⁶⁹

By 1994, Beale had begun spreading his most notorious lie that he was a CIA agent.⁷⁰ Apparently the lie began as a joke by Beale’s coworkers, which Beale then seized upon and spun into a full blown false identity.⁷¹ In fact, Beale has admitted to investigators that he perpetrated this lie to “puff up the image of [himself].”⁷²

Starting in 1998, Beale tested the waters with another scheme to abuse his position: he claimed to suffer from back pain to receive first-class travel accommodations.⁷³ In total, Beale claimed about \$300,000 in travel expenses, and “[h]is first-class airfares often were more than five times the amount of coach fares. In one case . . . his first-class ticket was 14 times higher than the coach fare — \$14,000 instead of approximately \$1,000 for a round-trip flight.”⁷⁴ In addition to requesting first-class travel, Beale also developed a habit of greatly exceeding the allowed per diem expense rate.

Notably, the approving official for his excessive travel expenses was Beth Craig.⁷⁵ Craig was known to have “worked very closely with Beale and Brenner . . . having daily meetings with the two men.”⁷⁶ Craig admitted that she handled Beale’s travel expenses “differently than others” and essentially did not review them.⁷⁷ Instead, she “relied on the administrative staff to

⁶⁴ See *id.*

⁶⁵ Deposition of John C. Beale, *supra* note 7, at 122–23.

⁶⁶ See Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan); Memorandum of Interview of Addie Johnson from Office of Inspector Gen, Env’tl. Prot. Agency 3 (Apr. 10, 2013) (on file with Committee).

⁶⁷ Memorandum of Interview of Addie Johnson from Office of Inspector Gen, Env’tl. Prot. Agency 3 (Apr. 10, 2013) (on file with Committee).

⁶⁸ Beale Senior Leader Application, *supra* note 6.

⁶⁹ See FEDERAL EXECUTIVE DIRECTORY 368 (Rosalie C. Ruane ed., Sept./Oct. 1993 ed.).

⁷⁰ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁷¹ See Deposition of John C. Beale, *supra* note 7, at 86, 166.

⁷² Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan); see also Deposition of John C. Beale, *supra* note 7, at 27 (indicating that Beale invented the CIA lie based on his “fantasy”).

⁷³ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁷⁴ *Id.*

⁷⁵ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen, Env’tl. Prot. Agency 3 (June 18, 2013) (on file with Committee).

⁷⁶ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen., Env’tl. Prot. Agency 1 (Mar. 7, 2013) (on file with Committee).

⁷⁷ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen, Env’tl. Prot. Agency 3 (June 18, 2013) (on file with Committee).

review specific trip details and receipts.”⁷⁸ However, when Beale’s executive assistant raised concerns over “the excessive and abusive nature of Mr. Beale’s travel expenses,” Craig told her “not to question the expenses, which were authorized because Mr. Beale was a senior level official.”⁷⁹ Craig explained her questionable decision making was due to Brenner, who was “always support[ing] . . . and pushing for Beale” in areas from “travel funding [to] retention incentives.”⁸⁰ In fact, Craig blamed her overall lax supervision on how hard she thought it was “to question Beale’s behavior and travel expenses when it was supported by another senior executive,” Brenner.⁸¹

As appointed officials in the Clinton Administration began to exit the Agency in mid-2000, Brenner took advantage of the leadership vacuum and sought out opportunities to advance Beale at the Agency. At some point in the year, Beale’s bonus payments stopped, but Brenner swiftly pushed through another retention bonus in June 2000.⁸² Beale has since claimed that he never asked Brenner or any other EPA official to recommend him for a promotion or to submit applications for a bonus on his behalf, which suggests that Brenner acted to reinstate the bonus *sua sponte*.⁸³ This could help explain why the employment offers listed in the application were identical to the offers included in Beale’s 1993 certification, which should have raised suspicions among reviewing officials, including Bob Perciasepe, who approved the bonus payment.⁸⁴ Brenner’s intervention paved the way for EPA to pay Beale, an additional \$32,000 a year, on average, without interruption until 2013.⁸⁵

As the Clinton Administration began to disband in mid-2000, Brenner seems to have taken advantage of the leadership vacuum and sought out opportunities to advance Beale.

Less than two months after Beale received the reauthorization for his Retention Incentive Bonus, based on a recommendation from Brenner and an approval from Bob Perciasepe, Beale was promoted on August 23, 2000, to SL, a designation equivalent to Senior Executive Service for technical professionals in the federal government pay system.⁸⁶ At the time, SL designation made Beale among the highest paid, non-elected federal government employees.⁸⁷ This was the last time Beale would receive a promotion in pay-grade.

⁷⁸ *Id.*

⁷⁹ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁸⁰ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen, Env’tl. Prot. Agency 2 (June 18, 2013) (on file with Committee).

⁸¹ *Id.*

⁸² See Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibit 11 (listing Brenner as the requesting official for the bonus).

⁸³ Memorandum from Rep. Comm. Staff to Rep. Members, S. Comm. on Env’t & Pub. Works, Additional Facts Regarding EPA Negligence in Responding to Beale Fraud (Robert Brenner) (Feb. 6, 2014) (on file with Committee).

⁸⁴ ENVTL. PROT. AGENCY, REPORT OF EVALUATION AND CORRECTIVE ACTIONS 7 (Dec. 5, 2013).

⁸⁵ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁸⁶ *Id.*

⁸⁷ Statement of the Offense at 2, United States v. Beale, No. 1:13-cr-00247-ESH (D.D.C. Sept. 27, 2013).

Thereafter, Beale held the same “functional” title as Brenner — Deputy AA for OAR.⁸⁸ Notably, the promotion and bonuses Brenner requested eventually elevated Beale’s salary to exceed the statutory threshold for employees at his pay grade for four years.⁸⁹

Year	Aggregate Pay	Median Household Income	Beale's Salary in Excess of Average American Income
1991	\$ 79,630.00	\$30,126.00	\$49,504.00
1992	\$ 103,701.40	\$30,636.00	\$73,065.40
1993	\$ 107,572.80	\$31,241.00	\$76,331.80
1994	\$ 112,073.60	\$32,264.00	\$79,809.60
1995	\$ 115,784.00	\$34,076.00	\$81,708.00
1996	\$ 123,348.00	\$35,492.00	\$87,856.00
1997	\$ 122,836.80	\$37,005.00	\$85,831.80
1998	\$ 125,890.40	\$38,885.00	\$87,005.40
1999	\$ 130,225.60	\$40,696.00	\$89,529.60
2000	\$ 136,593.60	\$41,990.00	\$94,603.60
2001	\$ 145,472.60	\$42,228.00	\$103,244.60
2002	\$ 152,720.40	\$42,409.00	\$110,311.40
2003	\$ 158,929.00	\$43,318.00	\$115,611.00
2004	\$ 165,619.00	\$44,334.00	\$121,285.00
2005	\$ 171,401.00	\$46,326.00	\$125,075.00
2006	\$ 182,318.00	\$48,201.00	\$134,117.00
2007	\$ 186,314.00	\$50,233.00	\$136,081.00
2008	\$ 194,548.00	\$50,303.00	\$144,245.00
2009	\$ 202,620.00	\$49,777.00	\$152,843.00
2010	\$ 205,805.00	\$49,276.00	\$156,529.00
2011	\$ 213,840.00	\$50,054.00	\$163,786.00
2012	\$ 205,920.00	\$51,017.00	\$153,903.00

Source:
 1) <http://www.census.gov/hhes/www/income/data/historical/household/>
 2) Memorandum from Susan Smith, Team Leader, Executive Resource Division, Office of Admin. & Res. Mgmt., Envtl. Prot. Agency, Executive Overview Analysis of J. Beale Pay Issues Table 1 (Mar. 14, 2013) (on file with Committee).

⁸⁸ See FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 626 (Fall 2004 ed.); CARROLL'S FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 574 (Sept./Oct. 2000 ed.).

⁸⁹ Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Patrick Sullivan) (“Based upon his Senior Leader status and retention incentive bonuses, from 2000 to 2013, Mr. Beale was paid, on average, \$180,000 per year, an amount that exceeded statutory pay limits for federal employees at his grade for four of those years – 2007, 2008, 2009 and 2010.”).

At the same time, Beale also admittedly “began to engage in a pattern of time and attendance fraud in violation of 18 U.S.C. §641.”⁹⁰ In the beginning, Beale often failed to report for work on days when he placed “D.O. Oversight” on his calendar — approximately once per week.⁹¹ Beale has explained that he “created this time entry — a short-hand term to mean Directorate of Operations – Oversight,”⁹² responsible for covert operations at the CIA.⁹³ Furthermore, “Beale did not submit request[s] for annual leave for this time, and did not inform his supervisors as to the reason for his absences,”⁹⁴ but was never reprimanded for his unexcused time out of the office.⁹⁵

According to EPA’s Conduct and Discipline Manual, failure to report to duty for more than five consecutive days is a fireable offense.⁹⁶ Beale’s promotion to SL status made his calendar available to his supervisors and other co-workers both in written and electronic form.⁹⁷ However, Brenner’s ability and willingness to vouch for Beale created a space for Beale to nurture and grow this sensational fraud.

b. George W. Bush Years: Waning Influence and Testing Patience

EPA Investigators “found unwavering devotion [to Beale]. ‘He was known as the golden child, the go-to man . . . [e]verybody who had contact with him had nothing bad to say about the man.’”⁹⁸

— Special Agent, Office of Inspector General, Mark Kaminsky

The transition between the Clinton and George W. Bush Administrations marked a turning point for Beale and Brenner at the EPA. After playing a major role in the passage of the 1990 Clean Air Act Amendments, the two had been deeply involved in the implementation of the legislation through the rulemaking process in the 1990s. During the Clinton Administration, Beale first began testing the waters with his lies, including his infamous fabrication that he was an undercover CIA agent, as well his malaria and Vietnam claims. The early 2000s would bring about a reduction in the pair’s influence, but not in their efforts to take advantage of their stature at the Agency.

Faced with a loss of influence through official channels, Brenner used OPAR’s broad scope to dabble in everything and focus on nothing. According to one former high ranking EPA official, “Brenner had pet projects during [the] Bush years — nothing really substantive.”⁹⁹

⁹⁰ Sentencing Memorandum of John C. Beale, *supra* note 3, at 16.

⁹¹ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁹² Sentencing Memorandum of John C. Beale, *supra* note 3, at 16.

⁹³ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁹⁴ Statement of the Offense, *supra* note 87, at 2.

⁹⁵ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁹⁶ Env’tl. Protection Agency Order 3120.1, *Conduct and Discipline*.

⁹⁷ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

⁹⁸ Gaynor, *supra* note 59.

⁹⁹ Interview with former high-ranking Env’tl. Prot. Agency official by Rep. Staff, S. Comm. on Env’t & Pub. Works.

While Brenner started the Bush years as Deputy AA of OAR,¹⁰⁰ Bill Wehrum replaced him in July 2005, and Brenner retained only his title as Director of OPAR, no longer serving in a dual role.¹⁰¹ Colleagues, though, repeatedly emphasized that this move was a purposeful demotion for the untrusted Brenner,¹⁰² and news accounts of the reshuffle went so far as to note that Brenner “was never part of [departing OAR AA] Holmstead’s inner circle anyway.”¹⁰³ Brenner did retain, though, one of his primary vehicles of influence in his role as head of OPAR.¹⁰⁴

So broad was Brenner’s scope that political appointees “always wondered really what Brenner’s role was with the policy shop.”¹⁰⁵ Describing Brenner as a “fundamentally dishonest person,”¹⁰⁶ colleagues observed in Brenner a willingness to abuse his network of influence and noted that Brenner paid close attention to levers of power that others overlooked, noting, for example, that “he pa[id] a lot of attention to other things people don’t pay attention to, like bonuses.”¹⁰⁷ One of the people Brenner protected and continued to reward with lavish awards was his best friend and ally Beale.¹⁰⁸

With the election of President George W. Bush, Beale apparently contemplated retirement.¹⁰⁹ After testing his fraud during the Clinton years, Beale stayed at the Agency without any legitimate supervision. Indeed, as a SL, a promotion to which Brenner facilitated, Beale “did not have a supervisor besides an AA . . . That is a difference between a senior executive and a SL. As a senior executive, people report to you so there is inherent accountability. As a SL, Beale did not have that accountability.”¹¹⁰ Even so, Beale was reassigned in 2004 to the international portfolio within OAR¹¹¹ and again in 2007 to the amorphous role of Senior Policy Advisor.¹¹² At the time, colleagues witnessed Beale exploiting these roles — that were defined by a “longer-term strategic focus,”¹¹³ instead of the actual responsibilities involved in “day-to-day management”¹¹⁴ — to avoid doing any real work.

Since Beale had established among career staff that his responsibilities as a CIA agent required absences from EPA, he continued to perpetuate this fabrication with the new management team. After the confirmation of Jeff Holmstead as AA of OAR, Beale informed him that he had been, and would continue to be, out of the office approximately one day a week

¹⁰⁰ See CARROLL’S FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 581 (Nov./Dec. 2001 ed.).

¹⁰¹ See *Risk Policy Report: Personnel Changes Pave Way For Holmstead Aide To Head Air Office*, INSIDEEPA.COM, Aug. 2, 2005, <http://insideepa.com/Risk-Policy-Report/Risk-Policy-Report-08/02/2005/personnel-changes-pave-way-for-holmstead-aide-to-head-air-office/menu-id-1098.html>.

¹⁰² Interview of former high-ranking Env’tl. Prot. Agency official by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁰³ See *Risk Policy Report*, *supra* note 106.

¹⁰⁴ *Id.*

¹⁰⁵ Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁰⁶ Interview of former high-ranking Env’tl. Prot. Agency official, by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁰⁷ Interview of Marcus Peacock, former Deputy Adm’r, Env’tl. Prot. Agency, by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁰⁸ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

¹⁰⁹ See E-mail from John Beale to Barbara Pabotoy (Jan. 7, 2002, 05:24 EST) (on file with Committee).

¹¹⁰ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen., Env’tl. Prot. Agency 3 (June 18, 2013) (on file with Committee).

¹¹¹ See *Risk Policy Report*, *supra* note 106.

¹¹² See FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 605 (Fall 2007 ed.).

¹¹³ See *Risk Policy Report*, *supra* note 106.

¹¹⁴ See *id.*

for “D.O. Oversight” issues at the CIA.¹¹⁵ According to Holmstead, Beale informed him that he had been tapped by the CIA to review select agency activities as part of an advisory board, which required occasional absences from EPA, not that he was an actual CIA agent.¹¹⁶ Holmstead further recalls that Brenner likely participated in that meeting.¹¹⁷ Shockingly, Holmstead was the first person to whom Beale was compelled to account for his time off.¹¹⁸ When faced with Beale’s well-developed reputation, Holmstead accepted Beale’s assertions.¹¹⁹ According to Beale’s sentencing memorandum, “[t]his wholly contrived explanation for his periodic, unauthorized absences, which went unchallenged within the EPA, emboldened Mr. Beale to continue his time fraud.”¹²⁰

Beale’s time fraud was facilitated by career EPA officials, in addition to Brenner. Most notably, Beth Craig, a Deputy AA in OAR from 2000 to 2010,¹²¹ had the authority and responsibility to approve Beale’s timecards.¹²² In the ten year period in which she served as Deputy AA, she has admitted that she “held [him] to a different standard.”¹²³ She approved and instructed staff to record and sign off on Beale’s hours, even during the period of time when he did not report to EPA offices for six months.¹²⁴ Beale’s administrative assistant was instructed at different times by both Beale and Craig “to put Beale in for eighty (80) hours of work each pay period unless instructed otherwise.”¹²⁵ When Beale’s assistant brought her concerns about his absences and the time entries to Craig, Craig explained to her that “Beale worked for EPA, but from a different location.”¹²⁶ The former director of Human Resources within OAR, Omayra Salgado, also questioned the approval of Beale’s time cards during his absences.¹²⁷ Craig explained to her that “Beale worked for the CIA,” which ceased Salgado’s questioning of the matter.¹²⁸

EPA career officials, who frequently covered for Beale, actually emboldened him to perpetrate his fraud.

¹¹⁵ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

¹¹⁶ Interview of Jeffrey Holmstead, former Assistant Adm’r, Office of Air & Radiation, Env’tl. Prot. Agency, by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹¹⁷ Interview of Jeffrey Holmstead by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹¹⁸ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 16.

¹¹⁹ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

¹²⁰ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 17.

¹²¹ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen., Env’tl. Prot. Agency 2 (Nov. 12, 2013) (on file with Committee).

¹²² *Id.* at 3.

¹²³ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen., Env’tl. Prot. Agency 2 (June 18, 2013) (on file with Committee).

¹²⁴ Memorandum of Interview of Addie Johnson from Office of Inspector Gen., Env’tl. Prot. Agency 1 (Apr. 10, 2013) (on file with Committee).

¹²⁵ *Id.*

¹²⁶ *Id.* at 2.

¹²⁷ Memorandum of Interview of Omayra Salgado from Office of Inspector Gen., Env’tl. Prot. Agency 2 (May 13, 2013) (on file with Committee).

¹²⁸ *Id.* at 3.

Towards the end of the Bush Administration, Beale was absent for six months allegedly due to an “election-year multi-agency project relating to candidate security” with the CIA.¹²⁹ Beale admitted under oath that he “never produced any written work” for the EPA during this absence.¹³⁰ Evidence from this period suggests that Beale’s disinterest in fulfilling his basic responsibilities at the EPA under the Bush Administration stood in stark contrast to the excitement displayed by him and his allies about the incoming Obama Administration. Email exchanges between Beale and his friends and colleagues reflect their lack of “enthusiasm for dealing with the dying remnants of what these Bush guys have left behind at EPA”¹³¹ and an eagerness to get then-Senator Obama elected.¹³² Even in the midst of his ongoing fraud and deceit, Beale impressed colleagues by suggesting that he was secretly out “keep[ing] Obama safe!”¹³³

c. Obama Administration: Pinnacle of Fraud

“Beale ‘walked on water at EPA’ due to his work on the [Clean Air Act] and other policy issues in the early 1990s.”¹³⁴

– Notes from Office of Inspector General interview with Administrator Gina McCarthy

Given Beale’s reputation from the Clinton years, and protection from EPA career officials like Brenner and Craig during the Bush years, the incoming Obama officials believed Beale to be a highly respected senior official who should not be questioned. Such fortification emboldened Beale to perpetrate his fabrications and expand his fraud to an unprecedented level under the Obama Administration. Overall, Beale’s time and attendance fraud during the Obama Administration amounted to \$239,059, as compared to the \$138,827 collected during the George W. Bush years.¹³⁵

Shortly after her confirmation as Assistant Administrator for OAR in July 2009, Gina McCarthy met Beale for lunch to discuss his work at the Agency, where he told her that he also worked for the CIA.¹³⁶ However, McCarthy did not recall whether Beale specifically told her he worked at the CIA, as Beale suggests; rather, she said it was a “well known secret” that Beale “worked” for

**Beale’s reputation
among his EPA
colleagues assisted him
in evading any basic
level of scrutiny.**

¹²⁹ See Sentencing Memorandum of John C. Beale, *supra* note 3, at 18.

¹³⁰ *Id.* at 4.

¹³¹ E-mail from Jeff Clark to John Beale (Aug. 19, 2008, 04:29 EST) (on file with Committee).

¹³² See E-mail from Nancy Kete to Robert Brenner, John Beale, & Barbara Brenner (Nov. 4, 2008, 11:30 EST) (on file with Committee).

¹³³ E-mail from John Beale to Linda Fisher (Oct. 30, 2008, 10:44 EST) (on file with Committee).

¹³⁴ Memorandum of Interview of Gina McCarthy from Office of Inspector Gen., Env’tl. Prot. Agency 1 (Feb. 27, 2013) (on file with Committee).

¹³⁵ See INST. FOR ENERGY RESEARCH, DIRTY BUSINESS AT THE EPA: A REPORT ASSESSING THE ADMINISTRATIVE FAILURES THAT ENABLED THE FRAUD OF JOHN C. BEALE 5 (2014).

¹³⁶ Deposition of John C. Beale, *supra* note 7, at 18.

the CIA.¹³⁷ In 2010, McCarthy sent a note to OAR staff announcing that Beale would be resuming his role as the immediate office's lead for all of OAR's international work and added that she was "very excited to finally get the opportunity to work closely with him."¹³⁸ McCarthy also told investigators that she was very impressed with Beale's intelligence and leadership ability.¹³⁹ Yet, at some point in 2010, McCarthy questioned Deputy Administrator Bob Perciasepe about Beale's CIA employment status.¹⁴⁰ At the time, Perciasepe said he did not have personal knowledge of it, but was aware of Beale's claims.¹⁴¹ By 2011, Perciasepe informed McCarthy there were no CIA agents at the Agency and advised her to "find out if [Beale's claims were] true."¹⁴² Despite Perciasepe's instruction, McCarthy did not query Beale's CIA claims until late 2012.

It is clear that Beale's reputation among his colleagues assisted him in evading any level of scrutiny. According to Beth Craig, she never questioned Beale's qualifications because he was known as a "loyal employee with a great reputation."¹⁴³ Craig Hooks, AA for the Office of Administration and Resources Management (OARM) also stated that one of the reasons no action was taken in 2010 when the OIG first uncovered Beale's pay issues was due to Beale's reputation and status as a Deputy AA.¹⁴⁴

Brenner also enjoyed a strong reputation at the Agency, which he seemingly used to bend the rules to benefit himself and his friends outside the Agency. One political appointee of both the Clinton and Obama EPA remarked that Brenner "enjoyed a lot of respect in the organization."¹⁴⁵ However, Brenner was known to have had too cozy of a relationship with at least one D.C. lobbyist, Patrick Rahe. Two independent sources familiar with both Brenner and Rahe told EPW staff that the pair had a "standing weekly golf date and their wives vacationed together."¹⁴⁶ As a federal employee, Brenner was restricted from accepting gifts from sources outside the government.¹⁴⁷ Despite a clear prohibition, in 2010, Brenner accepted an \$8,000 discount on a new Mercedes-Benz, brokered by Rahe.¹⁴⁸ At the time Brenner received the discount, Rahe was outside counsel for Mercedes-Benz.¹⁴⁹ Notably, Brenner had previously

¹³⁷ Memorandum of Interview of Gina McCarthy from Office of Inspector Gen., Env'tl. Prot. Agency 2 (Feb 27, 2013) (on file with Committee).

¹³⁸ E-mail from Gina McCarthy to Office of Air and Radiation, Env'tl. Prot. Agency (Dec. 3, 2010 07:44 EST) (on file with Committee).

¹³⁹ Memorandum of Interview of Gina McCarthy from Office of Inspector Gen., Env'tl. Prot. Agency 2 (Feb 27, 2013) (on file with Committee).

¹⁴⁰ *Id.*

¹⁴¹ *Id.*

¹⁴² Memorandum of Interview of Robert Perciasepe from Office of Inspector Gen., Env'tl. Prot. Agency 3 (Nov. 18, 2013) (on file with Committee).

¹⁴³ Memorandum of Interview of Elizabeth Craig from Office of Inspector Gen., Env'tl. Prot. Agency 4 (Nov. 12, 2013) (on file with Committee).

¹⁴⁴ Memorandum of Interview of Craig Hooks from Office of Inspector Gen., Env'tl. Prot. Agency 2 (Nov. 18, 2013) (on file with Committee).

¹⁴⁵ Robin Bravender, *EPA: A close friendship riven by lies*, GREENWIRE (Mar. 12, 2014), <http://www.eenews.net/greenwire/stories/1059996021>.

¹⁴⁶ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works. Two independent sources confirmed this claim.

¹⁴⁷ See *Gifts & Payments*, U.S. OFFICE OF GOV'T ETHICS, <http://www.oge.gov/Topics/Gifts-and-Payments/Gifts---Payments/> (last visited Mar. 11, 2014).

¹⁴⁸ Oversight & Gov't Reform Hearing, *supra* note 11 (testimony of Robert Brenner).

¹⁴⁹ *Id.*

secured Raheer a perennial spot on the Clean Air Act Advisory Committee (CAAAC), a senior-level policy committee established in 1990 to advise EPA on implementing the Clean Air Act Amendments.¹⁵⁰

On December 7, 2010, the Department of Justice Public Integrity Unit reported to the EPA OIG that Brenner received the discount on the Mercedes-Benz.¹⁵¹ On December 15, 2010, the OIG attempted to interview Brenner; however, citing the advice of his attorney, Brenner refused to be interviewed.¹⁵² Thereafter, the OIG started an investigation to determine whether there was an administrative violation or if any other employee in OAR had accepted such a discount.¹⁵³ According to the OIG, the investigation also raised allegations of bribery and improper acceptance of a gratuity.¹⁵⁴

d. The Escape Plan: Joint “Retirement”

Beale recalled that they had the joint retirement party because he, Brenner, and Clark had been “like the three Musketeers on the Clean Air Act.”¹⁵⁵

– Deposition of John Beale

While the EPA OIG was investigating Brenner and suspicions of Beale ramped up among career staff, the two announced their impending retirements. After the OIG attempted to interview Brenner about the Mercedes-Benz discount in December 2010, Brenner announced his retirement.¹⁵⁶ Despite the fact that Brenner was being investigated by the FBI and EPA OIG, in connection with his acceptance of an illegal gift, then-EPA Administrator Lisa Jackson still awarded Brenner a Distinguished Career Service Award.¹⁵⁷ After accepting this final accolade from the Obama Administration, Brenner officially retired on August 13, 2011.¹⁵⁸ According to the OIG, “[b]ecause Brenner had retired from the EPA before the criminal investigation was declined for prosecution by the DOJ, the matter was administratively moot and no further investigation or findings were made.”¹⁵⁹ On February 3, 2012, the DOJ declined the case for criminal prosecution.¹⁶⁰

¹⁵⁰ Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁵¹ Short-Form Report of Investigation from Office of Inspector Gen., Env’t. Prot. Agency 1 (Feb. 2013) (on file with Committee).

¹⁵² *Id.* at 2.

¹⁵³ *Id.*

¹⁵⁴ *Id.*

¹⁵⁵ Deposition of John C. Beale, *supra* note 7, at 191.

¹⁵⁶ *Id.*

¹⁵⁷ PANEL BIOGRAPHIES: ROBERT D. BRENNER, EPA’S CARE PROGRAM 100TH GRANT CELEBRATION PARTNERSHIP PANEL BIO SKETCHES (2011), available at <http://www.epa.gov/care/documents/2011Panelbios.pdf>.

¹⁵⁸ Short-Form Report of Investigation from Office of Inspector Gen., Env’t. Prot. Agency 2 (Feb. 2013) (on file with Committee).

¹⁵⁹ *Id.*

¹⁶⁰ *Id.*

Following the lead of his mentor and friend, Beale announced his retirement in May 2011.¹⁶¹ On May 4, 2011, McCarthy approved a draft email to be sent to all OAR staff announcing Beale's imminent retirement from the Agency:

As you all know, John has been a vital part of EPA and the OAR leadership for more years than he cares to remember. He is beginning to look forward to his retirement in the near future, but thankfully has agreed to work on some key efforts in the near-term.¹⁶²

Beale stopped showing up to work at EPA in June 2011.¹⁶³ On September 22, 2011, Beale, Brenner, and Jeff Clark, another career official within OAR, held a retirement party on the "Celebrity Yacht" on the Potomac River. Many senior EPA officials, including Bob Perciasepe and Gina McCarthy, were present to celebrate.¹⁶⁴ McCarthy described the retirement party as a "big deal."¹⁶⁵ However, Beale, one of EPA's highest paid employees, never filed his retirement paperwork.¹⁶⁶ His ability to continue to collect his salary without doing any work for EPA was facilitated by the arrangement he made with McCarthy before he "left" the Agency, as he had no set termination date.¹⁶⁷

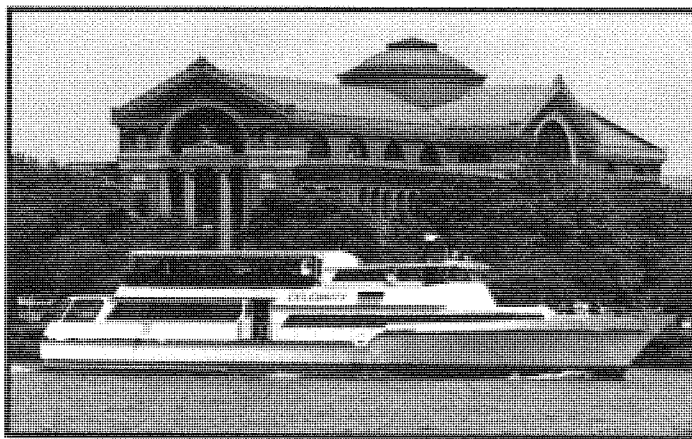


Photo of *Celebrity*, the second largest yacht in the Capitol Yacht Charters fleet.

¹⁶¹ E-mail from Gina McCarthy to John Beale (May 3, 2011, 21:00 EST) (on file with Committee).

¹⁶² *Id.*

¹⁶³ Statement of the Offense, *supra* note 87, at 4.

¹⁶⁴ Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

¹⁶⁵ Memorandum of Interview of Gina McCarthy from Office of Inspector Gen., Env'tl. Prot. Agency 2 (Feb 27, 2013) (on file with Committee).

¹⁶⁶ Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Patrick Sullivan).

¹⁶⁷ See Press Release, S. Comm. on Env't & Pub. Works Minority Office, Eye on the EPA: Gina McCarthy's Role in the John Beale Saga (Feb. 4, 2014), available at http://www.epw.senate.gov/public/index.cfm?FuseAction=Minority.Blogs&ContentRecord_id=f0b4633d-b9d0-9c23-24b3-f3f1e0ccb62.

On March 29, 2012, an OAR official raised concerns about Beale's retirement when he informed McCarthy that Beale was still on payroll.¹⁶⁸ Despite being aware of the fact that one of her subordinates was collecting a paycheck without providing any work product, this arrangement continued for seven more months before McCarthy ever contacted Beale.¹⁶⁹ In December 2012, McCarthy met with Beale for the first time in nearly fifteen months, and he informed her that he was no longer planning on retiring.¹⁷⁰ Two more months passed before concerns with Beale were officially reported to the OIG.¹⁷¹ On April 30, 2013, McCarthy had cause to fire Beale, but instead elected to allow him to voluntarily retire with full benefits.¹⁷² Beale did not confess that he had been lying about his affiliation with the CIA until June 14, 2013¹⁷³ — only after the OIG arranged for him to come to CIA headquarters in Langley to verify his claims.¹⁷⁴

As a testament to the bond between Beale and Brenner, Brenner permitted Beale to reside with him in Arlington, Virginia, throughout Beale's court proceedings and testimony before Congress.¹⁷⁵ While testifying before the U.S. House of Representatives Committee on Oversight and Government Reform, Brenner repeatedly declined to answer questions from the Committee Chairman, narrowly defining the scope of his supposed cooperation.¹⁷⁶ Additionally, Brenner has declined to respond to EPW Republican requests for information regarding Beale. In response to a series of questions posed in a letter from Senator David Vitter (R-LA),¹⁷⁷ Brenner responded with only short, perfunctory answers, frequently citing his prepared statement for the House hearing and repeatedly asserting that he was "unable to recount" or "recall" the answers to the questions.¹⁷⁸ In response to a follow-up letter from Senator Vitter, Brenner refused to cooperate on any level, simply stating: "Your six-page letter of October 15, 2013, seeks details of events from many years ago and references issues that have no connection to Mr. Beale's time and attendance fraud. Given these circumstances we respectfully decline your request for further information."¹⁷⁹

Even after Beale's voluntary confession and subsequent conviction on December 18, 2013, many of his former colleagues refuse to view him as a criminal. Some at EPA have clung to the narrative that Beale was CIA, and believe that Beale was being abandoned by his former

¹⁶⁸ E-mail from Scott Monroe to Gina McCarthy (Mar. 29, 2012, 09:59 AM EST) (on file with Committee).

¹⁶⁹ See Eye on the EPA: Gina McCarthy's Role in the John Beale Saga, *supra* note 171.

¹⁷⁰ Notes provided by Scott Monroe to Office of Inspector Gen., Env'tl. Prot. Agency 4 (2013) (on file with Committee).

¹⁷¹ Oversight & Gov't Reform Hearing, *supra* note 11 (testimony of Arthur Elkins).

¹⁷² *Id.* (statement of Patrick Sullivan).

¹⁷³ *Id.* (testimony of Patrick Sullivan).

¹⁷⁴ *Id.*

¹⁷⁵ *Id.* (testimony of Robert Brenner).

¹⁷⁶ *Id.* (questions of Rep. Issa and testimony of Robert Brenner) (illustrating how Brenner refused to answer questions unless he considered them "directly related" to matters that he defined as within the scope of his agreement to appear as a witness).

¹⁷⁷ See Letter from Sen. Vitter to Robert Brenner (Sept. 9, 2013) (on file with Committee).

¹⁷⁸ See Initial Letter from Justin Shur (citing Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Robert Brenner)).

¹⁷⁹ See Letter from Justin Shur to Rep. Staff, S. Comm. on Env't & Pub. Works (Nov. 8, 2013).

agency.¹⁸⁰ Moreover, former colleagues, including Lydia Wegman, Aron Anthony Golberg, and Kate Kimball, submitted letters to the Court asking for leniency in his sentencing.¹⁸¹ Shockingly, Mr. Goldberg, who was a career attorney in EPA's Office of General Counsel from 1988 to 2010, wrote the court: "[E]ven though I did not work with him very long, I found him to be one of the most capable people whom I knew during my career at EPA."¹⁸² Disturbingly, these officials' reaction to the scandal suggests that an individual can steal a million dollars from taxpayers and perpetrate a crime for nearly two decades, but still be considered — by some — as an environmental legend.

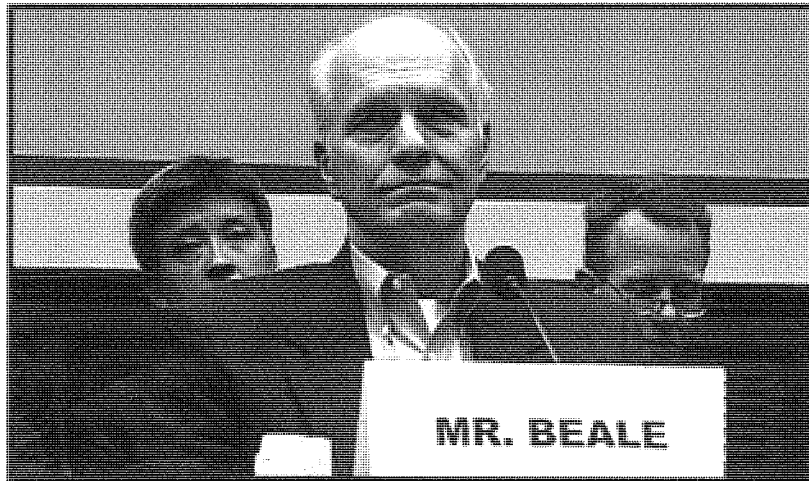


Photo of John Beale before the House Committee on Oversight and Government Reform, in which he invoked his Fifth Amendment right against self-incrimination (October 1, 2013).

¹⁸⁰ Robin Bravender, *Newsmaker: The name is Beale. John Beale*, E&E PUBLISHING, Oct. 28, 2013, <http://www.eenews.net/stories/1059989515>.

¹⁸¹ See Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibits 2, 6–7.

¹⁸² See Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibit 2.

III. ESTABLISHING EPA'S PLAYBOOK: BEALE AND 1997 NAAQS

In each instance of deceit, Beale and Brenner relied on their stature and reputation within the Agency to insulate them from scrutiny. While their work on the 1990 Clean Air Act Amendments made them relevant at EPA and within the environmental community, their position as EPA legends was solidified only after finalizing the 1997 national ambient air quality standards (NAAQS) for Ozone and Particulate Matter (PM). This work was cited time and again as the basis for Beale's promotions and bonuses. In fact, it appears these efforts enabled Beale to maintain his distinction for years to come without the need to substantially produce any additional work product. Given the significance of this work, EPW Republicans have investigated Beale's involvement in the Clinton Administration's 1997 NAAQS process. The findings, as detailed in this section, reveal Beale and Brenner's leadership throughout the NAAQS process, which raises new questions about the science underlying the standards.

a. Beale and Brenner's Tentacles Through EPA

OPAR was Brenner's "fiefdom" where he was considered to be the "most influential career person at [the] Agency, [as] head of OPAR."

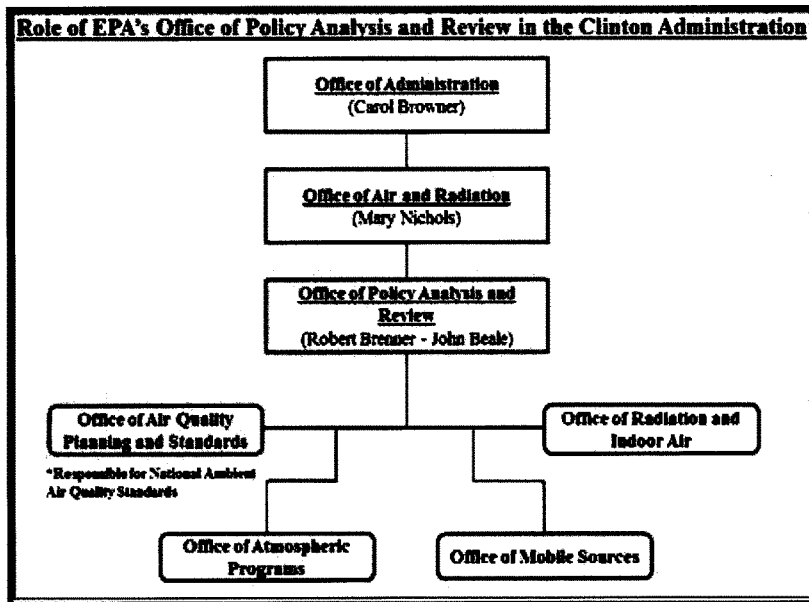
– Former High Ranking EPA Official

Beale and Brenner's reign within the Office of Air and Radiation (OAR) at EPA truly began when they took ownership of the process to develop and promulgate the NAAQS in 1997. This opportunity was set in motion when Brenner assumed the position of Office of Policy, Analysis, and Review (OPAR) Director within OAR in 1988. Soon after obtaining his new title, Brenner hired Beale as a Senior Policy Advisor, specially housed under Brenner in OPAR.¹⁸³ By 1991, Beale was given the title of Deputy Director for OPAR.¹⁸⁴ Over the years, Beale and Brenner's influence permeated the Agency because of their post in OPAR, an office that was subsequently dismantled after Brenner's retirement and Beale's absence from the Agency.¹⁸⁵

¹⁸³ Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Patrick Sullivan). *But see* Sentencing Memorandum of John C. Beale, *supra* note 3, at 7 (claiming that Beale was hired as a "Policy Analyst"); Beale Senior Leader Application, *supra* note 6 (asserting that Beale was promoted to Senior Policy Analyst in January of 1994).

¹⁸⁴ See Rob Brenner & John Beale, *Pizza at Midnight*, EPA JOURNAL, Jan.–Feb. 1991, at 54, 54.

¹⁸⁵ After the 2010 elections, a former Democratic staffer on the House Energy and Commerce Committee, Lorie Schmidt, was hired as Deputy Director of OPAR, see Darren Samuelsohn, *EPA beefs up policy shop with Hill aide*, POLITICO, Jan. 20, 2011, <http://www.politico.com/news/stories/0111/47921.html>, and after Brenner's retirement, she succeeded him as Director of OPAR. See CARROLL PUBLISHING, FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 517 (2012 annual ed.). However, by 2013, OPAR was de-listed from the EPA staff directory, see CARROLL PUBLISHING, FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL (Summer 2013 ed.), and Schmidt had assumed the portfolio of Associate General Counsel for Air and Radiation. See *Lorie Schmidt*, AM. BAR ASS'N SECTION OF ENV'T, ENERGY, AND RES. 42ND ANNUAL SPRING CONFERENCE, http://abaseerspring.conferencespot.org/Lorie_Schmidt (last visited Feb. 2, 2014). EPA is now seeking to contract out the OPAR portfolio. See *Analytical Support Services for Air & Radiation Programs—Solicitation Number: SOL-NC-14-00001—Original Synopsis*, FEDERAL BUSINESS OPPORTUNITIES, https://www.fbo.gov/index?s=opportunity&mode=form&tab=core&id=a7c7ba70b785d5b4f5dd0c0640b2752d&_cview=0 (last visited Mar. 6, 2014).



OPAR's exact role within OAR remains somewhat opaque, and descriptions offered of its role have ranged from the ambiguous to the downright cryptic. Beale referred to the "primary mission" of OPAR as "provid[ing] policy and program support, whether in the form of analysis or review, to [OAR]."¹⁸⁶ Brenner offered this description of OPAR:

That office is in charge of coordinating some of the regulatory activities that go on in the Office of Air and Radiation. It also helps coordinate some of the work we do along with the [C]ongressional office, with Congress, answering questions and providing analyses requested by Congress in assessing legislation. We assist with communications and outreach work and various--we try to help improve OAR's capabilities in several analytic areas such as risk assessment and economics.¹⁸⁷

According to those outside the Agency, OPAR was "structured to be flexible, with the capability of responding quickly and efficiently to the priorities of the Agency and especially the

¹⁸⁶ Sentencing Memorandum of John C. Beale, *supra* note 3, at 5.

¹⁸⁷ Transcript of Interview of Robert David Brenner at 5-6, H. Comm on Oversight & Gov't Reform, 110th Cong. (Feb. 8, 2008) (emphasis added) (on file with Committee).

Assistant Administrator of OAR.”¹⁸⁸ The office provided support “at times[] directly to the Administrator and Deputy Administrator of the EPA.”¹⁸⁹ These nebulous descriptions are consistent with the notion that OPAR’s lack of a clearly defined mission allowed Brenner and Beale to intervene and influence the trajectory of any number of projects throughout OAR and EPA.

Under Beale and Brenner’s control, OPAR grew in both scope and influence within the Agency. Brenner was known as a “policy guy” and Beale was a “hybrid policy and knowledgeable/institutional guy.”¹⁹⁰ Yet, Beale has described Brenner as “a much better economist than [he] . . . and [Beale] did basically everything else.”¹⁹¹ Interestingly, Brenner was initially hired to work on economic analysis,¹⁹² while neither he nor Beale had any formal economics education or experience.¹⁹³ Despite these deficiencies, they were known as an extremely effective pair who could “get things done.”¹⁹⁴ According to Lydia Wegman, one of their close colleagues from the 1990s, Beale “could be counted upon to learn the substance of the issues at hand, explain them clearly and forcefully to others both within and outside EPA.”¹⁹⁵

As for Brenner, former EPA official Bob Sussman recounted that “[m]ost people would say that [Brenner] made a very big contribution and was really one of the pillars of the air office.”¹⁹⁶ Colleagues considered him “ubiquitous”¹⁹⁷ and assert that he developed a “Machiavellian”¹⁹⁸ network — not just in OAR but throughout EPA. Career officials “felt beholden to him.”¹⁹⁹

For nearly two decades, Beale and Brenner stretched the boundaries of OPAR’s authority. In particular, following the 1990 Clean Air Act Amendments, which Beale and Brenner pioneered, the duo could claim ownership of all regulations implementing the amendments. According to Beale, upon passage of the amendments, he “took over the overall management of the implementation of those Amendments. Working as chairman of the Clean Air Work Group, [Beale] managed the efforts of several hundred EPA technical staff in four OAR Program Offices to ensure the necessary implementing regulations were developed and published as directed by the legislation.”²⁰⁰ His role was elaborated upon by current Deputy

¹⁸⁸ *Office of Policy Analysis and Review (OPAR)*, CENTER FOR A NEW AMERICAN SECURITY: THE BIG ENERGY MAP WIKI, <https://sites.google.com/site/bigenergymap/independent-agencies-and-government-corporations/environmental-protection-agency/office-of-air-and-radiation/office-of-policy-analysis-and-review-opar> (last visited Mar. 6, 2014).

¹⁸⁹ *Analytical Support Services for Air & Radiation Programs*, *supra* note 188.

¹⁹⁰ Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁹¹ Deposition of John C. Beale, *supra* note 7, at 172–73.

¹⁹² Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁹³ *See supra* Section I.

¹⁹⁴ Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁹⁵ Sentencing Memorandum of John C. Beale, *supra* note 3, at 24.

¹⁹⁶ Robin Bravender, *EPA: A close friendship riven by lies*, GREENWIRE (Mar. 12, 2014), <http://www.eenews.net/greenwire/stories/1059996021>.

¹⁹⁷ Interview of former high-ranking Env’tl. Prot. Agency official by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁹⁸ Interview of Marcus Peacock by Rep. Staff, S. Comm. on Env’t & Pub. Works.

¹⁹⁹ Interview of former high-ranking Bush Admin. Env’tl. Prot. Agency official, by Rep. Staff, S. Comm. on Env’t & Pub. Works.

²⁰⁰ Beale Senior Leader Application, *supra* note 6.

Administrator Bob Perciasepe, in his former position as AA for OAR during the Clinton Administration, who stated:

Beale [was] responsible for EPA's Clean Air programs He [was] responsible for assisting the Assistant Administrator in planning, policy implementation, direction and control of EPA's programs in these areas. These programs are both national and international in scope, involve numerous variables, and have a significant bearing on the pollution control programs of the Agency. . . . Beale coordinates the overall strategy for the Clean Air Act amendments analyses and develops strategic planning initiatives for Clean Air issues. He is also responsible for planning, developing, organizing, and assisting in the implementation of EPA's air pollution control programs.²⁰¹

While "everyone in OPAR was fully engaged in the [CAA] Amendments,"²⁰² Beale and Brenner distinguished themselves from the crowd by carefully crafting certain amendments' implementing regulations. In particular, by spearheading the 1997 NAAQS for ozone and PM, Beale and Brenner established their reputations that sustained through later years of unproductivity and malfeasance at EPA.

b. 1997 NAAQS Made Beale an EPA Legend

*"To his colleagues at the Environmental Protection Agency, John Beale was always a man of great import. Beginning in the early 1990s, he enjoyed one policymaking triumph after another, eventually establishing himself as a towering figure within the agency."*²⁰³

– *Washingtonian Magazine*

As the pinnacle of their careers, the duo hand-picked the most high profile program in OAR to advance their influence at the Agency. In 1995, they took ownership of the National Ambient Air Quality standards (NAAQS) for Ozone and PM.²⁰⁴ Under the Clean Air Act EPA must create NAAQS for criteria pollutants, including ground-level ozone and PM.²⁰⁵ Ozone is created when sunlight mixes with volatile organic compounds (VOCs) and nitrogen oxides.²⁰⁶ Notably, VOCs, one of the two precursors to ozone formation, is also considered particulate matter.²⁰⁷ PM is a "mixture of extremely small particles and liquid droplets"²⁰⁸ in air which vary

²⁰¹ Memorandum from Bob Perciasepe to Romulo Diaz, Assistant Adm'r, Office of Admin. & Res. Mgmt., ENVT. Prot. Agency, Retention Allowance (June 22, 2000) (emphasis added) (on file with Committee).

²⁰² Deposition of John C. Beale, *supra* note 7, at 172.

²⁰³ Gaynor, *supra* note 59.

²⁰⁴ Sentencing Memorandum of John C. Beale, *supra* note 3, at 13.

²⁰⁵ See 42 U.S.C. § 7408 (2006); National Ambient Air Quality Standards for Ozone, 61 Fed. Reg. 65,716 (proposed Dec. 13, 1996) (later codified at 40 C.F.R. pt. 50).

²⁰⁶ *Ozone and Your Patients' Health Training for Health Care Providers*, ENVT. PROT. AGENCY, <http://www.epa.gov/apti/ozonehealth/what.html> (last visited Mar. 10, 2014).

²⁰⁷ *Id.*

²⁰⁸ *Particulate Matter (PM)*, ENVT. PROT. AGENCY, <http://www.epa.gov/pm/> (last visited Mar. 10, 2014).

in size and include, for example, “smoke, fumes, soot, and other combustion byproducts” as well as “natural particles such as windblown dust, sea salt, pollen, and spores.”²⁰⁹

For each criteria pollutant, EPA must set a primary and secondary standard to ensure “an adequate margin of safety” for the public health, public welfare, and the environment. Every five years, EPA is required to review the scientific literature to determine if the present standard for each pollutant needs revision. When conducting such review, the Administrator has the option to keep the standard the same, increase the standard, or lower the standard. In the case of the 1997 NAAQS for ozone and PM, under Beale’s leadership EPA took the unprecedented action of proposing standards for the two pollutants in tandem and aggressively tightened the standards to controversial levels.

**Nearly two decades after
Beale’s triumph on the
1997 NAAQS, EPA
continues his strategy.**

The 1997 Ozone and PM NAAQS set in motion a permanent practice of EPA promulgating burdensome regulations under the Clean Air Act. Under their control, Beale and Brenner demonstrated how far EPA’s regulatory arm could reach. Namely, the duo set in motion a strategy to game the new system by compressing OIRA’s review, relying on secret science, and inflating benefits while underestimating costs. Nearly two decades later, EPA continues to engage in this strategic behavior and has relied on health benefits associated with decreases in PM_{2.5} and ozone to justify the majority of their Clean Air Act rules.

Beale and Brenner not only led EPA’s internal process for finalizing the NAAQS, they served as the face of EPA in advocating for these changes before stakeholders.²¹⁰ Brenner described the standards as one of the CAA Amendments’ “most challenging regulations: . . . [the] planning process for achieving air quality standards.”²¹¹ Yet Beale has admitted that among OPAR staff, only he and Brenner were involved in the process;²¹² Brenner “dealt with the impact statements and the economic analysis and review, and [Beale] did basically everything else on the NAAQS.”²¹³

Despite the fact that Brenner outranked Beale, it appears that Brenner purposefully handed the reins over to his acolyte, who was clearly beholden to him. Beale served as “the lead staff person”²¹⁴ with “day-to-day participation”²¹⁵ on the 1997 NAAQs, Beale’s authority was

²⁰⁹ Douglas W. Dockery, *Health Effects of Particulate Air Pollution*, 19 ANNALS OF EPIDEMIOLOGY 257, 257 (2009), <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3367838/#R10>.

²¹⁰ Illustratively, at Inside EPA’s conference Clean Air 2000: Regulation and Politics, Beale and Brenner were selected as panelists to discuss the 1997 Ozone and PM NAAQS: “The NAAQS panels will d[uj]g into the issues surrounding the proposed new standards themselves and their implementation. . . . John C. Beale, Deputy Director, EPA O[PAR], . . . discuss[ed] the standards themselves. Then the standards’ implementation w[ere] analyzed by . . . Robert D. Brenner, Director, EPA O[PAR].” *Clean Air 2000 Conference to Feature Two Panels on Proposed NAAQS*, INSIDE EPA, Mar. 28, 1997, at 14.

²¹¹ Oversight & Gov’t Reform Hearing, *supra* note 11 (statement of Robert Brenner).

²¹² Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

²¹³ Deposition of John C. Beale, *supra* note 7, at 172–73.

²¹⁴ *Id.* at 172.

²¹⁵ Sentencing Memorandum of John C. Beale, *supra* note 3, at 13.

broad in scope. Evidence suggests that Beale used the NAAQS as a vehicle for his own self-aggrandizement. Through the NAAQS process, Beale rose above reporting just to Brenner and began to work alongside Mary Nichols, the AA for OAR at the time.²¹⁶ EPW staff has learned from sources familiar with the 1997 NAAQS process that “Beale acted as Nichols’ Deputy and had some real clout.”²¹⁷

Beale’s handling of the 1997 NAAQS extended his influence for the first time to the EPA Administrator. Prior to the NAAQS, Beale never worked directly with the EPA Administrator.²¹⁸ Beale explained that during the “early years” of the Clinton Administration, he only met with Administrator Browner “maybe five or six times a year.”²¹⁹ However, according to Beale’s sentencing memorandum, “due to the importance of the NAAQS, Mr. Beale often worked directly with then-Administrator of the EPA [Carol Browner] to report on the progress of the project and to ensure that it achieved the Agency’s regulatory policies.”²²⁰ Beale explained that after he initiated the NAAQS process, he and Browner met “several times a week.”²²¹

As the capstone of his EPA career, Beale took ownership of the 1997 NAAQS for Ozone and Particulate Matter.

While the 1997 NAAQS ultimately proved to be a boon for Beale’s reputation at EPA, his management of the process codified an environmental regulatory behemoth that has continued to burden the American economy.

i. Beale’s PM_{2.5} “Policy Choice” Made History

Beale’s ascent at EPA was not seamless; there was a great deal of controversy over the process EPA used to set the 1997 NAAQS. Beale’s sentencing memorandum explains that “EPA had not previously worked on two major air quality standards simultaneously, and the time table for the project took on a degree of urgency due to a strict, court-ordered schedule”²²² set by an American Lung Association (ALA) lawsuit.²²³ As such, the 1997 NAAQS for PM and ozone

²¹⁶ Deposition of John C. Beale, *supra* note 7, at 59. Nichols previously served as a senior staff member at the Natural Resources Defense Council and is now chair of the California Air Resources Board. *See Mary Nichols*, UCLA INSTITUTE OF THE ENVIRONMENT AND SUSTAINABILITY, http://www.environment.ucla.edu/people/person.asp?Facultystaff_ID=10 (last visited Mar. 7, 2014).

²¹⁷ Interview of former Counsel, H. Comm. on Commerce, by Rep. Staff, S. Comm. on Env’t & Pub. Works.

²¹⁸ *See* Deposition of John C. Beale, *supra* note 7, at 174.

²¹⁹ *Id.*

²²⁰ Sentencing Memorandum of John C. Beale, *supra* note 3, at 13.

²²¹ Deposition of John C. Beale, *supra* note 7, at 174.

²²² Sentencing Memorandum of John C. Beale, *supra* note 3, at 13.

²²³ On Oct. 6, 1994, the ALA sued to force the EPA to make a decision about ozone and PM. The case resulted in consent decree ordering proposed PM standards by November 29, 1996 and final rule by July 19, 1997. *See Am. Lung Ass’n v. Browner*, 884 F. Supp. 345 (D. Ariz. 1994).

illustrate one of the first examples of EPA employing the practice of “sue and settle,”²²⁴ whereby friendly plaintiffs sue the Agency and agree to settle on mutually agreeable terms reached behind closed doors without public participation.²²⁵

In the case of the 1997 NAAQS, the ALA lawsuit resulted in a consent decree ordering EPA to propose standards for PM by November 29, 1996, and to issue final standards by July 19, 1997.²²⁶ The consent decree was silent on the deadline for Ozone NAAQS. When EPA sent the proposed standards to the Office of Management and Budget (OMB) for review on November 4, 1996, the proposal included not just standards for PM, but ozone as well.²²⁷ EPA was not required to reconsider the ozone standard until 1998, since the Agency had just completed a review of ozone in 1993.²²⁸ However, it appears that Beale and Brenner made a “policy call”²²⁹ and determined that the Agency should propose standards for ozone in conjunction with the PM standards, which were subject to the court-imposed deadline. In proposing the Ozone and PM NAAQS in tandem, many scientific and analytical uncertainties were overlooked or deliberately ignored to comply with the compressed timeline.

EPA also admitted in court papers filed pursuant to the ALA lawsuit that any period shorter than December 1, 1998, for final promulgation of the PM standard “would require the EPA to reach conclusions on critical scientific and policy issues with enormous consequences for society before it has had an adequate opportunity to collect and evaluate pertinent scientific data” and further reiterated that the time was needed to reach “a sound and scientifically supportable decision.”²³⁰ Further, the Clean Air Scientific Advisory Committee (CASAC), which is required under the CAA to review existing scientific literature and recommend NAAQS to the Administrator informed EPA in January 1996:

It should be emphasized that the Panel feels strongly that EPA should negotiate with the plaintiffs for a meaningful extension of the court-imposed deadlines for review . . . In the present review, the Panel had less than a month to review a

²²⁴ See Press Release, S. Comm. on Env't & Pub. Works Minority Office, 2013 Year End Review: Advancing the Dialogue on Sue and Settle (Dec. 19, 2013), available at http://www.epw.senate.gov/public/index.cfm?FuseAction=PressRoom.PressReleases&ContentRecord_id=7934F304-9FAF-7EE2-D0FF-47BB105D2893.

²²⁵ ALA received close to five million dollars in EPA grants from 1990 to 1995. See ANGELA ANTONELLI, THE HERITAGE FOUNDATION, BACKGROUNDER: CAN NO ONE STOP THE EPA? 2 (1997).

²²⁶ See *Am. Lung Ass'n*, 884 F. Supp. at 345.

²²⁷ See National Ambient Air Quality Standards for Ozone, 61 Fed. Reg. 65,716 (proposed Dec. 13, 1996) (later codified at 40 C.F.R. pt. 50).

²²⁸ See 42 U.S.C. § 7409(d)(1) (2006). The EPA agreed as part of a court case in 1993 to expedite the next Ozone review. See Memorandum from Andrew Wheeler to S. Comm. on Env't & Pub. Works, Subcomm. on Clean Air, Wetlands, Private Property, & Nuclear Safety, Clean Air Act Oversight Hearing on Ozone and Particulate Matter Science Issues (Feb. 5, 1997) (on file with Committee).

²²⁹ CAA provides the Administrator with the authority to promulgate new standards either earlier or more frequently than required. See 42 U.S.C. § 7409(d)(1) (2006).

²³⁰ *Clean Air Act: Ozone and Particulate Matter Standards: Hearings Before the Subcomm. on Clean Air, Wetlands, Private Property and Nuclear Safety and the S. Comm. on Env't & Pub. Works*, 105th Cong. 297 (1997) [hereinafter February 1997 EPW Hearing] (questions of Sen. Inhofe) (quoting *Am. Lung Ass'n*, 884 F. Supp. at 345).

voluminous amount of material. Some of the material was not adequately reviewed because of time constraints.²³¹

Despite these concerns over the tight deadline expressed by EPA and its scientific advisors, Beale and Brenner were able to push the standards forward relying on scientific data that 17 years later has yet to see the light of day.

1. Ignoring Inconvenient Science

The “policy choice” to simultaneously propose standards for ozone and PM was challenged on multiple fronts. In the first instance, scientific support was lacking due to the abbreviated analysis. According to CASAC, the science supporting a more stringent ozone standard was not sufficient.²³² Despite this pushback from CASAC, EPA moved forward with the standards which had two major flaws: EPA ignored key health effects of reduced ozone and dramatically downplayed the costs of the standard. Overall it has been characterized that “EPA’s decision appears to be an overzealous grab for more administrative authority and a willingness to ignore unpleasant facts.”²³³

Specifically, EPA did not consider negative health impacts of decreased ozone, which included an increase in malignant and non-melanoma skin cancers and cataracts from increased exposure to ultraviolet B (UV-B) rays.²³⁴ Other federal entities, such as the President’s Council of Economic Advisors as well as CASAC, brought the omission to EPA’s attention. According to the Department of Energy, EPA’s ozone standard would cause “twenty-five to fifty new melanoma-related fatalities per year, 130 to 260 new cases of cutaneous melanoma, and 2,000 to 11,000 new cases of non-melanoma skin cancer, as well as 13,000 to 28,000 new cases of cataracts yearly.”²³⁵ CASAC concluded that there was no “bright line” on the appropriate standard for ozone since EPA’s proposal was too close to background levels (naturally occurring) of ozone.²³⁶ At the time, 86 percent of volatile organic compounds — a key ingredient in ozone production — were naturally emitted from plants and trees.²³⁷ Accordingly,

²³¹ Letter from George T. Wolff, Chair, Clean Air Scientific Advisory Comm., to Carol Browner, Clean Air Scientific Advisory Committee (CASAC) Comments on the November, 1995 Drafts of the Air Quality Criteria for Particulate Matter and the Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information (OAQPS Staff Paper) 4 (Jan. 5, 1996), available at [http://yosemite.epa.gov/sab/sabproduct.nsf/BF3677846E679602852571A90065CC94/\\$File/casac03.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/BF3677846E679602852571A90065CC94/$File/casac03.pdf).

²³² See Letter from Clean Air Scientific Advisory Committee to Carol Browner, CASAC Closure on the Primary Standard Portion of the Staff Paper for Ozone (Nov. 30, 1995) [hereinafter CASAC Ozone Closure Letter] (on file with Committee).

²³³ Randall Lutter, *Economic Analysis and the Formulation of U.S. Climate Policy*, in PAINTING THE WHITE HOUSE GREEN: RATIONALIZING ENVIRONMENTAL POLICY INSIDE THE EXECUTIVE OFFICE OF THE PRESIDENT 46, 48 (Randall Lutter & Jason F. Shorgen eds., 2004).

²³⁴ See MICHAEL FUMENTO, POLLUTED SCIENCE: THE EPA’S CAMPAIGN TO EXPAND CLEAN AIR REGULATIONS 48 (1997) (citing Letter from Ari Patrinos, Assoc. Dir. for Health & Evtl. Research, Dep’t of Energy, to John Bachman, Office of Air Quality Planning & Standards, Env’tl. Prot. Agency (Jan. 4, 1995)).

²³⁵ *Id.*

²³⁶ CASAC Ozone Closure Letter, *supra* note 232, at 2.

²³⁷ FUMENTO, *supra* note 234, at 47 (citing Tom Spears, *Trees Contribute to Smog*, OTTAWA CITIZEN, Feb. 14, 1994, at A1).

CASAC determined that none of EPA's proposed standards for ozone were "significantly more protective of public health."²³⁸

Beyond the public health aspects, EPA also downplayed costs associated with the ozone standard. Although EPA continued to assert that the statute did not require a consideration of cost or benefits, under Executive Order 12866, EPA still had to measure the costs and benefits of the standards. As such, EPA strategically counted the cost of partial attainment of the standards, but measured this against the benefits to be derived from full attainment of the standards. However, there is no basis in the law that would permit partial compliance with the standard, so there was no basis for EPA's abbreviated analysis of cost. According to the Council of Economic Advisors at the time, the ozone standard could cost up to \$60 billion a year, as opposed to EPA's \$2.5 billion annual cost estimate that was based only on partial attainment of the standard.²³⁹

2. Beginning of PM_{2.5} Purported Benefits

As for the proposed PM NAAQS, EPA sought to regulate fine particulates (PM_{2.5}) in addition to larger particles (PM₁₀) for the first time under the NAAQS;²⁴⁰ however, neither CASAC nor the White House Office of Science and Technology Policy supported the decision to focus on PM_{2.5}. At the time of the 1997 NAAQS, there was no precedent at the Agency to regulate PM_{2.5} under the NAAQS. Previously, EPA regulated PM₁₀, which is equivalent in size to a piece of pollen or dust. The 1997 NAAQS marked the first time EPA regulated PM_{2.5}, which is a fourth of the size of PM₁₀ particles — so small it cannot be seen with the human eye. CASAC again challenged EPA's decision to regulate PM_{2.5} due to the weak scientific evidence on PM_{2.5} health effects. Despite the significant scientific concern, EPA — led by Beale — maintained its unwavering strategy for the standards.

CASAC's closure statement on the PM_{2.5} standard emphasized that based on the scientific literature EPA provided; they could not distinguish between adverse health effects of PM_{2.5} and PM₁₀.²⁴¹ One CASAC member maintained that "the selection of 2.5m cutpoint was arbitrary, and that the Agency should consider other cutpoints."²⁴² According to the CASAC Chair, "There [did] not appear to be any compelling reason to set a restrictive PM_{2.5} NAAQS at [the] time,"²⁴³ also highlighting that CASAC's "understanding of the health effects of PM[_{2.5}] is far from complete," "the deadlines did not allow adequate time to analyze, integrate, interpret, and debate the available data on this very complex issue," and "the previous NAAQS review

²³⁸ CASAC Ozone Closure Letter, *supra* note 232, at 2.

²³⁹ See Draft Memorandum from Alicia Munnell, Council of Econ. Advisers, Exec. Office of the President, to Art Fraas, Office of Info. & Regulatory Affairs, Office of Mgmt. & Budget, Exec. Office of the President (Dec. 13, 1996).

²⁴⁰ See Revisions to the National Ambient Air Quality Standards for Particulate Matter, 52 Fed. Reg. 24,634 (July 1, 1987) (codified at 40 C.F.R. pt. 50).

²⁴¹ See CASAC Ozone Closure Letter, *supra* note 232, at 2–3.

²⁴² Letter from George T. Wolff to Carol Browner 3 (Jan. 5, 1996), available at [http://yosemite.epa.gov/sab/sabproduct.nsf/BF3677846E679602852571A90065CC94/\\$File/casac03.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/BF3677846E679602852571A90065CC94/$File/casac03.pdf).

²⁴³ George T. Wolff, *The Particulate Matter NAAQS Review*, 46 J. OF THE AIR & WASTE MGMT. ASS'N 926 (1996).

took eight years to complete.”²⁴⁴ This time CASAC only had roughly a year and half to review the materials on PM before EPA had to propose the standards pursuant to the ALA lawsuit.²⁴⁵

Another concern with EPA’s proposed standards was the lack of data on actual human exposure to PM_{2.5}. In Congressional testimony, one CASAC member called on EPA to stop making such assertions because “that causal relationship has not been proven” and explained that there is “a consensus [among CASAC members] that, in the strictest sense, causality has not been proven.”²⁴⁶ Administrator Browner eventually admitted to the Senate EPW Committee that monitors for measuring human exposure to PM_{2.5} were limited to only 55 cities.²⁴⁷ By contrast, there were 1,700 cities equipped with PM₁₀ monitors.²⁴⁸ Given the lack of data resulting from the limited number of monitors, EPA was also unable to assess how many counties would be in nonattainment, something the Agency would need to know in order to calculate whether the standards achieved the requisite benefits.

These complaints were supported by the fact that EPA set the standards by relying on only a couple of studies. According to the President’s science advisors in the Office of Science and Technology Policy, “The database for actual levels of PM_{2.5} is also very poor, and only a handful of studies have actually studied PM_{2.5} per se.”²⁴⁹ In fact, of the five studies EPA relied upon in setting the PM NAAQS, only two of them conducted primary research on the effects of PM_{2.5}, while the conclusions of the other three were based solely on the primary research conducted by the other two.

3. Known Problems with Key Studies

The two studies EPA relied upon, known as the Harvard “Six Cities” and American Cancer Society (ACS II or CPS II) studies, were and remain controversial as they rely on primary research that was conducted more than 15 years prior to their selection by EPA — well before advancements in air quality. The Six Cities study was a long-term cohort study of the health effects associated with airborne pollutants, which dated back to 1970. Subjects were 8,069 randomly-selected adults living near coal-burning power plants in six U.S. cities that had a wide range of levels of ambient particles and gaseous pollutants. According to the study, there was a statistically significant relationship between PM and adverse health effects in three of the six cities, which formed the basis for a conclusion that those residing in polluted cities have a

²⁴⁴ Letter from Gerge T. Wolff to Carol Browner, Closure by the Clean Air Scientific Advisory Committee (CASAC) on the Staff Paper for Particulate Matter (June 13, 1996) [hereinafter CASAC PM Closure Letter], available at [http://yosemite.epa.gov/sab/sabproduct.nsf/C146C65BA26865A2852571AA00530007/\\$File/cas19608.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/C146C65BA26865A2852571AA00530007/$File/cas19608.pdf).

²⁴⁵ *Review of the EPA’s Proposed Ozone and Particulate Matter NAAQS Revisions: Joint Hearings before the Subcomm. on Health & the Env’t and the Subcomm. on Oversight & Investigations of the H. Comm. on Commerce*, 105th Cong. 40 (1997) [hereinafter April 1997 Commerce Hearing] (statement of George T. Wolff).

²⁴⁶ *Id.* at 132 (testimony of Joe Mauderly).

²⁴⁷ February 1997 EPW Hearing, *supra* note 230, at 297 (written response by Carol Browner to questions of Sen. Thomas).

²⁴⁸ *Id.*

²⁴⁹ Memorandum from Rosina Bierbaum, Acting Assoc. Dir., Office of Sci. & Tech. Pol’y, Exec. Office of the President, to Sally Katzen, Adm’r, Office of Info. & Regulatory Affairs, Office of Mgmt. & Budget, Exec. Office of the President, OSTP Questions for EPA On Its Proposed Revisions to the Ozone and Particulate Matter Air Quality Standards (Nov. 16, 1996), *quoted in* ANTONELLI, *supra* note 225.

26% greater chance of premature mortality than those in non-polluted cities.²⁵⁰ The ACS II study²⁵¹ had one cohort that looked at 295,000 adults recruited from 50 U.S. cities from 1982 to 1989 and was designed to study the impact of various factors on cancer development by looking at the relationship between mortality and air pollution.²⁵² The ACS II study identified a 17% higher mortality rate among those residing in the most polluted cities.²⁵³

Even though EPA relied on the 17–26% risk probability to justify the PM NAAQS, such low risk probabilities are statistically insignificant.²⁵⁴ Even Douglas Dockery, one of the authors of the Six Cities study, stated that these were “very weak effects.”²⁵⁵ In fact, at a February 12, 1997, EPW Committee hearing, Administrator Browner conceded that the five studies EPA relied upon failed to consider larger particles, such as PM₁₀, that could have been responsible for the alleged health effects. At the same hearing, Browner referenced a chart on the studies and highlighted the Six Cities study as finding a positive correlation; however, the study found alleged adverse health effects in only three of the six cities, so to the extent proof existed, it was merely a tie and not a positive correlation.²⁵⁶

In addition to the weak correlation between premature deaths and PM_{2.5} illustrated by these studies, the mortality estimates EPA used based on the ACS study were blatantly incorrect. In the November 1996 proposal, EPA estimated the standards would prevent approximately 40,000 premature deaths, which was reduced to 20,000 deaths in December 1996.²⁵⁷ By April 2, 1997, Mary Nichols, the Assistant Administrator for the Office of Air and Radiation, corrected the record to explain that the estimate should be 15,000.²⁵⁸

This correction spawned from a reanalysis by Dr. Kay Jones, a former senior advisor to the President’s Council on Environmental Quality during the Ford and Carter Administrations, who found that the ACS study contained a miscalculation. According to Dr. Jones, “EPA recently admitted it made a statistical error which resulted in a 25-percent over-estimation, or 5,000 annual deaths, of the annual long-term mortality from PM_{2.5}.”²⁵⁹ Thereafter, CASAC members stated that the changes to the findings demanded that EPA revisit the underlying data of the study. Specifically, CASAC member Roger McClellan told Congress he “would urge EPA not just to go back and change these points

**Evidence suggests
EPA inflated their
original benefits
estimates fortyfold.**

²⁵⁰ See Douglas W. Dockery et al., *An Association between Air Pollution and Mortality in Six U.S. Cities*, 329 NEW ENG. J. MED. 1753 (1993).

²⁵¹ C. Arden Pope et al., *Particulate Air Pollution As a Predictor of Mortality in a Prospective Study of U.S. Adults*, 151 AM. J. RESPIRATORY & CRITICAL CARE MED. 669 (1995).

²⁵² See *id.* at Tables 1–2.

²⁵³ See *id.*

²⁵⁴ See February 1997 EPW Hearing, *supra* note 230, at 201 (statement of Ronald Wyzga, Elec. Power Research Inst.); *id.* at 146–89 (statement of Anne E. Smith).

²⁵⁵ John Merline, *Clean Air Rules Under Attack*, INVESTOR’S BUS. DAILY, Dec. 11, 1996.

²⁵⁶ See Dockery et al., *supra* note 250.

²⁵⁷ See February 1997 EPW Hearing, *supra* note 230, at 222 (testimony of Carol Browner).

²⁵⁸ See Statement of Mary Nichols (Apr. 2, 1997) (on file with Committee).

²⁵⁹ KAY JONES, CITIZENS FOR A SOUND ECONOMY, IS THE EPA MISLEADING THE PUBLIC ABOUT THE HEALTH RISKS FROM PM 2.5?: AN ANALYSIS OF THE SCIENCE BEHIND EPA’S PM 2.5 STANDARD 1 (1997).

as where they are plotted. They ought to go back and take a look at what were the actual measurements in those 50 cities.”²⁶⁰

When Dr. Jones refined EPA’s estimates based on the new formula, he found that rather than 15,000 deaths per year, the estimate should be less than 1,000.²⁶¹ As Dr. Jones explained, “the agency has failed to recognize that the correction of the error causes the justification for the proposed PM_{2.5} standard to disappear.”²⁶² Moreover, Sally Katzen, Administrator of the Office of Information and Regulatory Affairs (OIRA), informed Congress that there was such “substantial scientific uncertainty in the risk analyses” that “additional work had to be done.”²⁶³ However, EPA did not conduct “additional work” and failed to acknowledge Dr. Jones findings, thereby finalizing the rule based on the incorrect estimate of 15,000 deaths per year, therefore, EPA dramatically inflated the benefits associated with reductions in PM_{2.5}.

Aside from the problematic findings of these studies, their design and methodology reveal that they were truly unreliable. The main issues with the studies include confounding variables that do not take into account such things as smoking history, physical fitness, or exact levels of exposure to pollutants, as well as levels of humidity and allergens in the air. They also did not take into account income differences among participants, which has been known to impact health status. As such, EPA experienced considerable opposition from CASAC and the public on the integrity of the science. However, in response to requests for the underlying data, EPA refused to share the data, as well as the underlying analysis, in the studies.

As for confounding variables, Douglas Dockery, one of the authors of the Six Cities study, said, “The potential for bias from confounding factors or variables we didn’t measure is certainly very large in these studies.”²⁶⁴ Moreover, the study found that among nonsmokers there was no statistically significant increase in mortality between the most polluted city and the cleanest city.²⁶⁵ In fact, if the authors had excluded participants who were exposed to “gases, fumes, or dust” at work, there was no increase in mortality at all.²⁶⁶ Therefore the only way the authors could draw affirmative conclusions about mortality was by including current and former smokers as well as those with exposures through their occupations as participants in the underlying health surveys.²⁶⁷

Moreover, the studies failed to apply the same level of exposure to all individuals in each city.²⁶⁸ In other words, the studies assumed that all participants received equal exposure to outdoor air rather than looking at individual exposure data. Had the authors considered

²⁶⁰ April 1997 Commerce Hearing, *supra* note 245, at 114 (testimony of Roger McClellan).

²⁶¹ JONES, *supra* note 259, at 1.

²⁶² *Id.*

²⁶³ April 1997 Commerce Hearing, *supra* note 245, at 176–77 (testimony of Sally Katzen).

²⁶⁴ Merline, *supra* note 255.

²⁶⁵ See Dockery et al., *supra* note 250, at 1753–59; see also FUMENTO, *supra* note 234, at 19–20 (commenting on this finding).

²⁶⁶ See Dockery et al., *supra* note 250, at 1753–59; see also FUMENTO, *supra* note 234, at 19 (commenting on this finding as well).

²⁶⁷ See Dockery et al., *supra* note 250, at 1753–59; see also FUMENTO, *supra* note 234, at 19–20 (explaining how statistical significance can only be derived by blurring the distinction between smokers, former smokers, and non-smokers).

²⁶⁸ See February 1997 EPW Hearing, *supra* note 230, at 204 (statement of Ronald Wyzga).

individual exposure, it would have been revealed that some individuals spent more time indoors than outdoors.²⁶⁹ Those spending more time indoors were more susceptible to the sorts of indoor pollution known to cause detrimental health effects.²⁷⁰

The Six Cities study also failed to consider changes in humidity and temperature, which would have been constructive given that higher temperatures were associated with a 30% increase in mortality.²⁷¹ This issue was broached by Senator Jeff Sessions (R-AL) during a February 1997 EPW Committee hearing in which one author of the Six Cities study, Dr. Schwartz, explained that they did not calculate for dewpoint, which is a measure of humidity, because “frankly [he] hadn’t seen humidity being put in lots of other studies.”²⁷² However, EPA even noted in its analysis provided to CASAC that “most [short-term PM studies] include temperature and dewpoint as covariates in their studies.”²⁷³

Rather than take responsibility of the process, Browner and Nichols deferred major decision making to Beale.

In addition, EPA encountered considerable opposition from CASAC for their continued reliance on such non-peer reviewed studies. CASAC warned EPA that the Six Cities study, in fact, was “not in the peer-reviewed literature” during CASAC’s review and noted it was unusual for EPA to “rely so heavily on non-peer-reviewed reports” and “numerous unpublished reports, many of which are recent EPA contractor reports.”²⁷⁴ Indeed, it was known that the scientists authoring the studies had an incentive to reach results that would force EPA to strengthen the standards, as some of the authoring scientists held posts on EPA Federal Advisory Committees and some received EPA research grants to produce the very data being used to justify the standards.²⁷⁵ Accordingly, the CASAC Chair George Wolff explained that “as a result, it is hard to judge the scientific credibility of many key studies that the Agency uses as a basis for their conclusions.”²⁷⁶

Given the uncertainties associated with such scientific literature, the CASAC chair explained that EPA’s decision was truly a “policy call.”²⁷⁷ Moreover, Nichols clarified that “while EPA does not base its decisions on the views of any individual CASAC member,” it is “a policy choice.”²⁷⁸ Who made the policy call seems unclear as senior EPA officials were not well versed on the science. Administrator Browner admitted that she did not read the studies, though

²⁶⁹ *See id.*

²⁷⁰ *See id.* at 202–03.

²⁷¹ Telephone interview by Michael Fumento with Roger McClellan (Apr. 11, 1997), *discussed in* FUMENTO, *supra* note 234, at 20.

²⁷² February 1997 EPW Hearing, *supra* note 230, at 83 (testimony of Joel Schwartz).

²⁷³ OFFICE OF AIR QUALITY PLANNING STANDARDS, ENVTL. PROT. AGENCY, REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER: POLICY ASSESSMENT OF SCIENTIFIC AND TECHNICAL INFORMATION V-44 (1996).

²⁷⁴ Letter from George T. Wolff to Carol Browner 3–4 (Jan. 5, 1996), *available at* [http://yosemite.epa.gov/sab/sabproduct.nsf/BF3677846E679602852571A90065CC94/\\$File/casac03.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/BF3677846E679602852571A90065CC94/$File/casac03.pdf).

²⁷⁵ *See id.*

²⁷⁶ *Id.*

²⁷⁷ April 1997 Commerce Hearing, *supra* note 245, at 34 (statement of George Wolff).

²⁷⁸ *Id.* at 163 (statement of Mary Nichols).

a couple months later she added that Mary Nichols, the Assistant Administrator for the Office of Air and Radiation, had read them.²⁷⁹ However, during a separate Congressional hearing, Mary Nichols testified that on certain issues with the NAAQS she deferred to John Beale, saying she “didn’t feel comfortable because [she] didn’t have as much detailed knowledge.”²⁸⁰ Accordingly, it appears that Browner and Nichols deferred to the “expertise” of EPA’s career staff — Beale and Brenner — to make this “policy call.”

4. A Process to Empower Unelected Bureaucrats

The process employed by EPA during the 1997 Ozone and PM NAAQS marked another important effort to undermine true scientific analysis: namely, reliance on the Staff Paper. The CAA directs EPA’s scientists in the Office of Research and Development to compile what is known as the Criteria Document, which includes all the relevant scientific literature on the standards for CASAC review.²⁸¹ There is no statutory basis for the Staff Paper; rather, EPA administratively created the document as an opportunity for career staff within OAR to summarize the lengthy and highly technical Criteria Document and recommend policy options for the Administrator.²⁸²

Some have argued that “EPA bureaucrats, without proper public input, drafted the paper, which included important recommendations about the science and the levels at which NAAQS should be set. Once completed, EPA’s [CASAC] reviewed it. By that time, the bureaucratic momentum to tighten the standard was difficult to resist.”²⁸³ According to the 1996 Staff Paper for PM NAAQS, authored by former OAR official John Bachmann, the document was “intended to help bridge the gap between the scientific review contained in the [Criteria Document] and the judgments required of the Administrator in setting ambient standards for PM.”²⁸⁴ Under Beale’s leadership on the 1997 NAAQS, the Staff Paper empowered career staff and limited information given to CASAC and the Administrator. For example, the fact that the 1997 PM NAAQS relied on only five studies, three of which were based on the underlying data from the Harvard Six Cities and ACS studies, was determined by the authors of the Staff Paper. The ploy worked, as Browner accepted standards listed in the Staff Paper.²⁸⁵

²⁷⁹ FUMENTO, *supra* note 234, at 34 (citing *Hearing of Subcomm. on Health & Env’t & Subcomm. on Oversight & Investigations, H. Comm. on Commerce*, 105th Cong. (May 15, 1997) (statement of Carol Browner)).

²⁸⁰ April 1997 Commerce Hearing, *supra* note 245, at 220 (testimony of Mary Nichols).

²⁸¹ See 42 U.S.C. § 7408(a)(2) (2006) (“Air quality criteria [documents] for an air pollutant shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of such pollutant in the ambient air, in varying qualities.”).

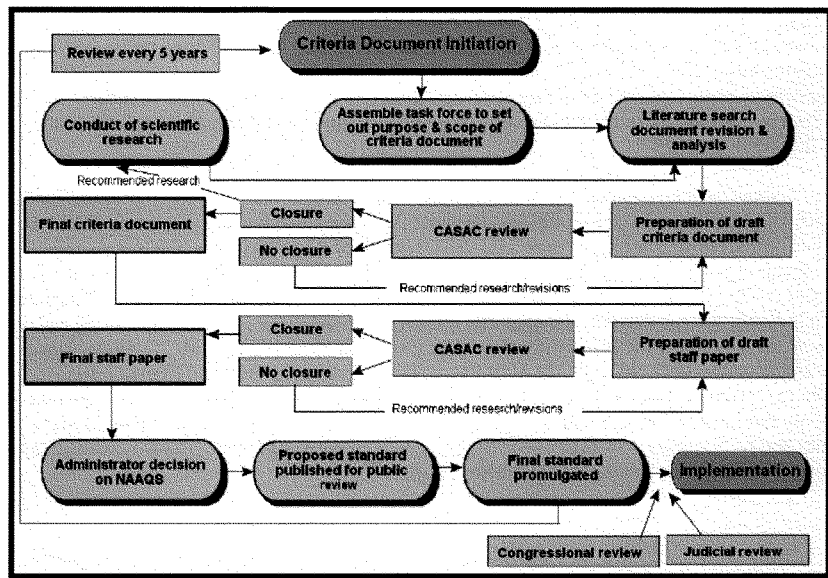
²⁸² JOHN BLODGETT & LARRY PARKER, CONG. RESEARCH SERV., 97-722, AIR QUALITY STANDARDS: THE DECISIONMAKING PROCESS 7–8 (2002).

²⁸³ *Fact of the Day: EPA Uses a Secretive Process to Set Ozone Standards*, CENTER FOR REGULATORY SOLUTIONS, <http://centerforregulatoryolutions.org/fact-of-the-day-march-4-2014/> (last visited Mar. 17, 2014).

²⁸⁴ OFFICE OF AIR QUALITY PLANNING & STANDARDS, ENVTL. PROT. AGENCY, REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER: POLICY ASSESSMENT OF SCIENTIFIC AND TECHNICAL INFORMATION (OAQPS STAFF PAPER) I-1 (1996) [hereinafter PM STAFF PAPER], available at <http://www.epa.gov/ttn/naaqs/standards/pm/data/1996pmstaffpaper.pdf>.

²⁸⁵ JAMES E. MCCARTHY, CONG. RESEARCH SERV., RL33807, AIR QUALITY STANDARDS AND SOUND SCIENCE: WHAT ROLE FOR CASAC? 7–8 (2008).

In an effort to restore the statutory requirements for setting NAAQS, the Bush Administration sought to reform the NAAQS process and eliminate the Staff Paper.²⁸⁶ Thereafter, the NAAQS process included a more focused and transparent policy assessment that would be published as an Advance Notice of Proposed Rulemaking in the Federal Register, open to public comments.²⁸⁷ However, as one of the first actions of the Obama EPA, then-Administrator Jackson almost immediately rescinded these reforms and reinstated the Staff Paper.²⁸⁸ Thus, following the approach of the Clinton Administration, the Obama Administration resurrected the Staff Paper to allow unaccountable EPA career staff primary control over the underlying science and standards — the exact model envisioned by Beale and Brenner.



NAAQS setting process depicted by Congressional Research Service Report 97-722 (April 9, 2002).

²⁸⁶ See Memorandum from Marcus Peacock to George Gray, Assistant Adm'r, Office of Research and Dev., & Bill Wehrum, Process for Reviewing National Ambient Air Quality Standards (Dec. 7, 2006), available at http://www.epa.gov/ttn/naaqs/pdfs/memo_process_for_reviewing_naaqs.pdf; see also MCCARTHY, supra note 285, at 9–10.

²⁸⁷ *Id.*

²⁸⁸ Press Release, Env'tl. Prot. Agency, EPA Administrator Lisa P. Jackson Brings Science, Transparency Back to Air Quality Standards Decisions (May 21, 2009), available at <http://yosemite.epa.gov/opa/admpress.nsf/0/20A6491703E9172E852575BD00585B81>.

ii. Beale Practices Damage Control over PM and Ozone NAAQS

While reviewing the Ozone and PM NAAQS, there was little to no consensus among those inside EPA or within the Administration on the appropriate level at which to set the standards. However, it appears Beale and Brenner ran a tight ship involving only key staff who could help the messaging and follow the strategy for advancing both standards as proposed. As head of OPAR, Brenner was known to have “an objective on NAAQS and would have done whatever to get the right outcome.”²⁸⁹ Beale’s sentencing memorandum noted that “[he] and several other senior managers, OPAR and the Air Office coordinated the efforts of EPA staff and scientists from across the Agency to put together a carefully planned and thoroughly researched set of proposed standards to recommend to the EPA Administrator.”²⁹⁰ Beale has further stated that under the direction of Mary Nichols, he took “the lead on managing that whole process, and that involves dealing with our scientists, our technicians, our engineers, everybody, and putting the whole package together.”²⁹¹

As for those outside the Agency, Beale “worked closely with the White House, OMB, and EPA’s constituents in industry and the environmental community.”²⁹² According to one EPA colleague, “John took the lead for EPA in the discussions with OMB and other agency reviewers.”²⁹³ At the time, OIRA had roughly three weeks to complete its review of the PM standards to meet the court-ordered deadline.²⁹⁴ Under Executive Order 12866, OIRA should have had 90 days to review a major proposed rule.²⁹⁵ Yet in this case, OIRA completed their review of the PM and ozone standards in less than 30 days, in time for the Agency to issue the proposed standards on the day before Thanksgiving, November 26, 1996,²⁹⁶ before the ALA imposed deadline. Given the added ozone standards and delayed submission to OIRA, OIRA’s review of the standards may have been compromised by the tight deadline. However, OIRA Administrator Sally Katzen argued that the review was adequate as “other obligations of the office were temporarily put aside so we could focus on these rules.”²⁹⁷ Despite Katzen’s claim that OIRA’s review was adequate, it appears that part of the benefit of the joint rule strategy for EPA was to minimize OIRA’s ability to review and influence the rule.

²⁸⁹ Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

²⁹⁰ Sentencing Memorandum of John C. Beale, *supra* note 3, at 13–14 (emphasis added).

²⁹¹ Deposition of John C. Beale, *supra* note 7, at 172.

²⁹² Sentencing Memorandum of John C. Beale, *supra* note 3, at 13–14.

²⁹³ *Id.* at Exhibit 7.

²⁹⁴ The proposal was sent to OMB on November 4, 1996, and the proposed rule for PM was due by November 29, 1996. See ANTONELLI, *supra* note 225, at 8.

²⁹⁵ Exec. Order No. 12,866, 3 C.F.R. 638 (1993), *reprinted as amended in* 5 U.S.C. § 601 app. at 88–92 (2012).

²⁹⁶ See ANTONELLI, *supra* note 225, at 8.

²⁹⁷ April 1997 Commerce Hearing, *supra* note 245, at 156 (testimony of Sally Katzen).

In addition to gaming the amount of time OIRA had to review the complicated proposals, evidence shows that Beale and Brenner even choreographed OIRA's role throughout the NAAQS review process. EPW staff has learned that at the time "there was a substantial disagreement between EPA and OIRA over analytical practices in the 1990s."²⁹⁸ The fundamental disagreement was exacerbated by the 1997 NAAQS for ozone and PM, which was one of the first major air regulations subject to the cost-benefit analysis requirement under Clinton's Executive Order 12866 on Regulatory Planning and Review. According to OIRA economists working on the NAAQS review, "EPA's ozone standard set a low in the use of bad analysis. . . . EPA's analytic errors [were] not inadvertent. They [were] the result of efforts to

**Beale and Brenner
orchestrated OIRA's
role throughout the
NAAQS review process.**

convince the public that the [ozone] rule was reasonable when the facts indicated otherwise. EPA manipulated its scientific advisers and the public review process."²⁹⁹

As Brenner handled the "impact statements and the economic analysis and review" of the NAAQS,³⁰⁰ it is no surprise that EPA's "estimates increased benefits and decreased costs and Brenner would always defend it."³⁰¹ In fact, during the NAAQS review, OPAR had "enforced a certain

discipline [during] this period of time: analysis presented the best face of the Agency."³⁰² A prime example of such presentation, and the level in which Beale and Brenner misled the public on the NAAQS, is illustrated by what is known as the "Beale Memo."

1. Beale Choreographs EPA's Response to Serious Concerns

Immediately after OIRA approved EPA's proposed NAAQS for PM and ozone, Congress raised concerns about the integrity of OIRA's review. Among the challengers, former House of Representatives Committee on Commerce, Chairman Thomas Bliley (R-VA), wrote OIRA requesting an independent assessment of EPA's economic analysis.³⁰³ According to an EPA official "heavily"³⁰⁴ involved in the NAAQS, Beale "took a leadership role in working with OMB, other executive branch agencies, Congressional staff, and outside stakeholders to address their concerns with the draft EPA standards."³⁰⁵ EPW staff has learned that when it came to regulatory review of the 1997 Ozone and PM NAAQS, "EPA officials made a concerted effort to suppress criticism of its proposals from OIRA."³⁰⁶ Such suppression is exemplified by the controversy surrounding and the content of the Beale Memo.

²⁹⁸ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

²⁹⁹ Lutter, *supra* note 233, at 46, 47, 61–62 (emphasis added).

³⁰⁰ Deposition of John C. Beale, *supra* note 7, at 172.

³⁰¹ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³⁰² Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³⁰³ See April 1997 Commerce Hearing, *supra* note 245, at 230–34.

³⁰⁴ Deposition of John C. Beale, *supra* note 7, at 173.

³⁰⁵ Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibit 7.

³⁰⁶ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

Beale went to great lengths to shape OIRA's response to Chairman Bliley. OIRA originally drafted a 27-page detailed analysis critical of EPA's proposed rules,³⁰⁷ which was then edited down to 15 pages based on advice from OIRA's general counsel. However, the final

**Beale intentionally
subverts transparency on
cost-benefit analysis.**

version OIRA sent to Bliley on January 15, 1997, was a fraction of the original letter, just seven pages of vague generalities favoring EPA's position.³⁰⁸ Bliley subsequently learned that someone at EPA had interfered with OIRA's response.³⁰⁹ The Chairman immediately questioned Mary Nichols on EPA's involvement.³¹⁰ At the time, Nichols explained that Brenner and Gary Guzy helped OMB with its response to Bliley;³¹¹ however, it was soon revealed that Beale was the EPA official who altered the

response. Specifically, Beale reviewed the draft OIRA letter and faxed OIRA the Beale Memo,³¹² explaining in no uncertain terms that OIRA had to alter the letter, stating:

[A]s written, the OMB's response could be very damaging to the PM and Ozone effort. Thus we strongly recommend that the OMB employ language much more similar to the language previously submitted by the EPA to the OMB in their response to Chairman Bliley . . . We are prepared to sit down with you and discuss the letter line by line.³¹³

Upon a review of the three versions of the letter, it appears that Beale was successful in extracting significant changes from OIRA. For instance, the original letter included a finding that EPA did not fully conform to the principles in the Best Practices document,³¹⁴ whereas the final version said it was consistent with the Best Practices document.³¹⁵ Moreover, statements that EPA may have overstated benefits and understated costs of fully attaining the standards, as well as virtually the entire assessment of EPA's cost and benefit analysis was excluded from the final letter.³¹⁶

Also curious is how the EPA hid Beale's involvement in altering the OIRA response. Mary Nichols' original response to Bliley excluded any reference to Beale.³¹⁷ Only after Bliley publicly released the Beale Memo and questioned Nichols under oath did she admit:

³⁰⁷ See April 1997 Commerce Hearing, *supra* note 245, at 234-60.

³⁰⁸ See *id.* at 282-88.

³⁰⁹ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³¹⁰ See April 1997 Commerce Hearing, *supra* note 245, at 291-94.

³¹¹ See *Leaked Memos Show Heavy EPA Influence on OMB's PM/Ozone Review*, INSIDEEPA.COM, Mar. 6, 1997.

³¹² See *id.* at 261-79.

³¹³ *Id.* (emphasis added).

³¹⁴ OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, ECONOMIC ANALYSIS OF FEDERAL REGULATIONS UNDER EXECUTIVE ORDER 12866 (1996).

³¹⁵ See April 1997 Commerce Hearing, *supra* note 245, at 248, 250-51.

³¹⁶ See *id.* at 282-88.

³¹⁷ See *id.* at 295-300.

[Beale] had called me expressing his concern that the OMB draft was going to be very critical in a way that he thought was unfair based on communications. . . . Beale expressed . . . his frustration. . . . [H]e asked whether I would talk to [OIRA head] Sally Katzen. I said I didn't feel comfortable because I didn't have as much detailed knowledge to do that, and that if he had concerns he ought to put them in writing and send them to [OIRA].³¹⁸

The Beale Memo was also excluded from EPA's original document production to Bliley.³¹⁹ Yet, in Nichols' response, she stated that the Agency went to "all the people that were believed to have had docs in response to Bliley's letter and those people searched their files and produced docs."³²⁰ However, an Administration source who knew that a responsive document had been wrongfully withheld, arranged for a secret meeting with a House staffer at a diner in the Virginia suburbs in order to turn over the Beale Memo.³²¹

Nichols later clarified that "there were people away or on vacation who had materials responsive."³²² Apparently, Beale was one of these individuals. At the time this drama was unfolding Beale had been lying to the Agency about having malaria, ostensibly to make himself unavailable for work when convenient.³²³ In this instance, it appears Beale's absence insulated himself from producing responsive documents, such as his memorandum, to Congress. EPW staff learned that at the time, EPA informed Bliley's staff that Beale had malaria, saying, "give us a break, he has malaria."³²⁴

When Bliley called for a hearing on the NAAQS, an EPA official said that EPA Administrator Carol Browner was "not the best person to testify on the matter, as she was not directly involved . . . Mary Nichols . . . and John Beale . . . should testify."³²⁵ Accordingly, Bliley invited both Beale and Nichols to testify for the Committee.³²⁶ Five days before the scheduled hearing, Nichols informed the Committee that neither she nor Beale would be available because she would be traveling and Beale had allegedly been ill³²⁷ — presumably from malaria. Beale never testified before Congress on the matter.

Beale was protected by his EPA colleagues and the process he engineered, as it appears he was never held accountable for altering OIRA's presentation of its NAAQS analysis.

³¹⁸ *Id.* at 219–20.

³¹⁹ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³²⁰ April 1997 Commerce Hearing, *supra* note 245, at 302.

³²¹ Interview with former Chief Counsel for Oversight & Investigations, H. Comm. on Commerce, by Rep. Staff, S. Comm. on Env't & Pub. Works.

³²² *Id.* at 301.

³²³ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³²⁴ Interview of former Counsel, H. Comm. on Commerce, by Rep. Staff, S. Comm. on Env't & Pub. Works.

³²⁵ *Commerce Panel May Subpoena Browner To Testify On EPA Discussions With OMB*, BNA, Mar. 14, 1997.

³²⁶ *Id.*

³²⁷ *Id.*

c. A Sustainable Strategy: Beale and Secret Science Above Reproach

*After his work on the 1997 NAAQS, Beale “had free reign . . . no one questioned Mr. Beale, ever. No one questioned his vouchers, no one questioned his time away from the office, no one questioned his work product.”*³²⁸

– Assistant Inspector General for Investigations, Patrick Sullivan

Soon after President Clinton endorsed the Ozone and PM NAAQS, the standards were finalized in July 1997 in compliance with the sue and settle deadline.³²⁹ EPA’s victory on NAAQS proved the effectiveness of Beale’s design of the EPA Playbook, which has empowered EPA’s career staff to expand the Agency’s regulatory reach in many instances beyond what sound science justifies. EPA celebrated the 1997 NAAQS standards as a turning point for air regulations.

The 1997 NAAQS ratified EPA’s Playbook and empowered career staff to expand the Agency’s regulatory reach beyond what science justifies.

As for Beale, he used his work on the 1997 NAAQS as the foundation necessary to secure his colleagues’ confidence, which paved the way for his future lies and abuse of his leadership position at the agency. At his sentencing hearing, Beale’s attorney stated as much, asserting that Beale’s fraud was a “result of the trust he gained from work on CAA in the 90s.”³³⁰ Beale himself elaborated that “for over a decade of service I was honest and gained trust of my coworkers . . . then I exploited management at EPA.”³³¹ During the NAAQS process, Beale won the respect of environmentalists and key stakeholders, which he parleyed into promotions, bonuses, and unquestioning respect at the EPA.

i. EPA Shielded the Secret Science

The studies EPA relied upon for the 1997 Ozone and PM NAAQS were clearly vulnerable to even the most basic scrutiny, which prompted CASAC and others to probe EPA for the underlying data. Even before EPA proposed the standards, CASAC explained that given EPA’s reliance on “certain [non-peer-reviewed] studies,” they were “left with uncertainty as to

³²⁸ Oversight & Gov’t Reform Hearing, *supra* note 11 (testimony of Patrick Sullivan).

³²⁹ National Ambient Air Quality Standards for Particulate Matter, 62 Fed. Reg. 38,652 (July 18, 1997) (later codified at 40 C.F.R. pt. 50); National Ambient Air Quality Standards for Ozone, 62 Fed. Reg. 38,856 (July 18, 1997) (later codified at 40 C.F.R. pt. 50).

³³⁰ Transcript of Sentencing Hearing, United States v. Beale, No. 1:13-cr-00247-ESH (D.D.C. Sept. 27, 2013) [hereinafter Beale Sentencing Hearing].

³³¹ *Id.*

the validity of either reported analysis” for the studies.³³² Accordingly, CASAC told EPA that “[t]he answer to this dilemma seems clear: The EPA should take the lead in requesting that investigators make available the primary data sets being analyzed so that others can validate the analyses.”³³³

In response to CASAC’s request, EPA promised they would work on getting the data and more studies, but reinforced that CASAC needed to finish its review.³³⁴ CASAC completed its review; however, EPA did not fulfill its promise. As EPA moved forward with the proposed standards, the Agency sought to protect the underlying data rather than comply with these requests to ensure scientific integrity.

At the time, EPA’s reason to withhold the data was questionable and seemed to be an outgrowth of the type of policy decisions made by Beale and Brenner. For example, in response to Congressional requests for the underlying data, Mary Nichols failed to provide a sound justification; she simply proclaimed “EPA does not believe that review of the raw data underlying these studies is necessary.”³³⁵

EPA actively obstructed transparency, shielding the studies from any meaningful review.

Moreover, Nichols deferred to the institutions, claiming that she “urged them to make the data underlying their studies available to interested parties.”³³⁶ This request was a charade as Nichols knew the authors would not provide others access to their cherished data. Unsurprisingly, Harvard asserted that the law prevented them from releasing participants’ personal information; despite the fact that the law permitted them to provide the data so long as they removed any personal information.³³⁷

Once the standards were close to being finalized, Mary Nichols moved to protect the underlying data, stating:

While EPA believes that, as a general principle, data underlying these and other studies should be made available, the Agency respects the fact that revealing underlying data can raise significant proprietary, legal and ethical issues concerning confidentiality. Many of these studies use highly personal information, including medical data, which were obtained through promises of confidentiality.³³⁸

³³² Letter from George T. Wolff & Roger McClellan to Carol Browner 2 (May 16, 1994), available at [http://yosemite.epa.gov/sab/sabproduct.nsf/A0D2AE11E6AD6E44852571BD00581CE8/\\$File/PM10+DATA+SET+S++CASAC-COM-94-005_94005_4-27-1995_38.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/A0D2AE11E6AD6E44852571BD00581CE8/$File/PM10+DATA+SET+S++CASAC-COM-94-005_94005_4-27-1995_38.pdf).

³³³ *Id.*

³³⁴ Interview by Rep. Staff, S. Comm. on Env’t & Pub. Works.

³³⁵ April 1997 Commerce Hearing, *supra* note 245, at 166.

³³⁶ *Id.*

³³⁷ See Letter from James H. Ware, Dean for Academic Affairs, Harvard Univ., to Dan Greenbaum, Health Effects Inst. 2 (Apr. 8, 1997) (on file with Committee).

³³⁸ April 1997 Commerce Hearing, *supra* note 245, at 166.

With this proclamation, Nichols and EPA took a position that obstructed transparency, shielding the studies from any meaningful review. The Six Cities authors reinforced EPA's position when they claimed that the law prevented them from releasing participants' personal information; however, the data could have been provided as long as any personal information was removed. This apparent coordination to hide the science brought EPA's Playbook full circle.

The perpetual excuses did not satisfy the public and other stakeholders' desire to confirm the integrity of the underlying data and the studies' results. In response to building public criticism, the institutions made an agreement to allow the Health Effects Institute (HEI) to conduct a reanalysis of the studies.³³⁹ Thereafter, EPA pointed to the pending HEI reanalysis in response to requests for the underlying data and claimed that such reanalysis "appropriately accommodates these interests."³⁴⁰ However, it would take several years for this analysis to be completed, buying time for Beale and Brenner to push forward with their aggressive air regulations under the Clinton Administration.

ii. Beale Made Friends in the Right Places During NAAQS

As a result of his work on NAAQS, Beale made several important friends within the Agency who paved the way for his future abuses. Such individuals include EPA officials in OAR: Lydia Wegman; John Bachmann; and Jeff Clark. These individuals were part of OAR's Office of Air Quality Planning Standards (OAQPS) based in North Carolina — and are the primary gatekeepers for the science used to justify NAAQS standards. These individuals continued to support Beale throughout his career at EPA, even after he was exposed as a felon facing criminal charges.

As a senior official in OAQPS, Lydia Wegman lived and worked out of EPA's Research Triangle, North Carolina. Lydia was "close to Beale" and became his "ally."³⁴¹ In her own words, Wegman said, "[i]n 1996 and 1997, I worked with John on developing revised NAAQS for ozone and particulate matter."³⁴² EPW staff has learned that during the NAAQS process, "Lydia was 'part of Air braintrust,'"³⁴³ and similar to Beale, she was known as a "policy person."³⁴⁴

³³⁹ See Letter from James H. Ware, Dean for Academic Affairs, Harvard Univ., to Dan Greenbaum, Health Effects Inst. (Apr. 8, 1997) (on file with Committee).

³⁴⁰ April 1997 Commerce Hearing, *supra* note 245, at 166.

³⁴¹ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³⁴² *Id.*

³⁴³ Interview of Marcus Peacock by Rep. Staff, S. Comm. on Env't & Pub. Works.

³⁴⁴ *Id.*



Photo of Lydia Wegman aired on C-SPAN 2 (August 21, 2001).

During the sixteen years Wegman and Beale were jointly employed by EPA's air office, the two did not work together after the 1997 NAAQS.³⁴⁵ Accordingly, it appears the short period of time the two worked together on the 1997 NAAQS had a lasting impact on their friendship: they frequently communicated via email or phone and spent time together outside of their EPA employment. For example, in January 2012, during a period of time in which Beale's supervisors believed he had retired while he actually remained on EPA payroll, Lydia emailed him on his EPA account saying that she left him a voicemail and wanted to give him a "hug" and was "hoping I might see you again tomorrow AM if you were coming here to meet Harnett and Bachmann . . . please know that I am sending you a hug and hoping that we'll see each other again before too long."³⁴⁶ Beale replied that he would call her later and told her:

You are a very special person to me and I hope we will be able to stay in touch over the years to come. You and Jeff and a handful of folks in DC EPA mean so much to me. You are such a strong person and an unflinching force for the public interest, honoring the science, and treating all with the respect and courtesy deserved. . . . You are a role model for me in many ways.³⁴⁷

³⁴⁵ Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibit 7 ("I did not work closely with [Beale] on other projects after the conclusion of the NAAQS regulatory process in 1997.").

³⁴⁶ E-mail from John Beale to Lydia Wegman (Jan. 6, 2012, 03:50 EST) (on file with Committee).

³⁴⁷ *Id.*

Interestingly, after more than 30 years of employment at EPA, Wegman announced her retirement in August 2013 soon after the Department of Justice filed its charges against Beale.³⁴⁸ Wegman's retirement was effective just before Beale pled guilty to fraud on September 27, 2013.³⁴⁹

Another key official in the NAAQS who was close to both Wegman and Beale was John Bachmann. Like Wegman, Bachmann was an EPA career official who resided and worked in North Carolina for OAQPS. EPW staff has learned that Bachmann was "the real mastermind behind PM."³⁵⁰ In fact, Bachmann was the primary author of the 1997 PM NAAQS Staff Paper.³⁵¹ EPW staff has learned that besides Beale, Bachmann was the only other official in OAR known to hold a SL position.³⁵² As previously explained, SL employees were not subject to the same constraints as SES employees, but received an equally extravagant pay as SES employees.

Beale also became particularly close to another longtime EPA career official, Jeff Clark. Notably, in 1994 Clark was promoted to a high level policy position in OAQPS and worked closely on the NAAQS.³⁵³ Clark was the third person to join Beale and Brenner's retirement cruise on the Potomac in September 2011. According to Beale; he, Brenner, and Clark were "like the three Musketeers on the Clean Air Act."³⁵⁴ Like many of the allies Beale collected, Clark maintained close ties to environmentalist groups³⁵⁵ and shared his friend's disdain for the Bush Administration's lack of hyper-regulatory zeal.³⁵⁶

iii. Beale Used NAAQS to Advance Fraud

Aside from the close friendships acquired during the 1997 NAAQS process, Beale used his leadership on the Ozone and PM NAAQS as a justification for nearly all of his monetary awards. In 2000, Beale's work on the NAAQS was referenced in his retention incentive bonus application, explaining that his "key role" in "air-quality-control activity is now in a critical period" due to Congressional and judicial challenges to the NAAQS.³⁵⁷ That same year Beale used the NAAQS in his application for a promotion to SL, stating:

³⁴⁸ Jason Plautz, *Will retirement of 2 senior scientists hinder critical air reviews?*, GREENWIRE, Aug. 30, 2013, <http://www.eenews.net/greenwire/stories/1059986569/search>.

³⁴⁹ *Id.*

³⁵⁰ Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³⁵¹ PM STAFF PAPER, *supra* note 284, at I-1.

³⁵² Interview by Rep. Staff, S. Comm. on Env't & Pub. Works.

³⁵³ See FEDERAL EXECUTIVE DIRECTORY 393 (Sept./Oct. 1994 ed.).

³⁵⁴ Deposition of John C. Beale, *supra* note 7, at 191.

³⁵⁵ For example, one of Clark's emails to Beale forwarded a message from Vickie Patton of the Environmental Defense Fund regarding a "rising star" in environmental efforts for the individual's generous donations to Pres. Obama and Democratic candidates. See E-mail from Jeff Clark to John Beale (July 14, 2008, 03:11 EST) (on file with Committee).

³⁵⁶ E-mail from Jeff Clark to John Beale (Aug. 19, 2008, 04:29 EST) (on file with Committee).

³⁵⁷ Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibit 11.

I managed the efforts of several groups of EPA senior managers and staff to develop several of EPA's most significant initiatives. As part of these efforts, I also managed the preparation of Congressional testimony and briefed Congressman and their staffs, high-ranking EPA and Administration officials, (including the EPA Administrator) [among] the most significant of the initiatives I managed . . . was the development of new, more stringent National Ambient Air Quality Standards (NAAQS) for ozone and particles. . . . The project involved the development and assessment of major scientific research products from both EPA researchers and outside contractors, as well as intensive discussions with senior White House officials, senior industry managers, environmental scientists, state and local governments, public interest groups, and Members of Congress and their staffs. This project included the direct involvement of President Clinton, who formally charged EPA with implementing the new standards according to a cost effective plan that I designed and negotiated. The result was the successful completion of what would normally be a five-year rulemaking process in less than four years, the product being two new air-quality standards that will make the air cleaner for millions of Americans. Once the standards were completed, I managed the Presidentially mandated implementation process, again leading a large team of EPA managers and staff to ensure that the standards will be met in a cost effective manner.³⁵⁸

Over a decade later, Beale would still cling to his glory days with the 1997 NAAQS. A 2010 email — prepared by Beale and sent to EPA staff from then-AA for OAR Gina McCarthy announcing Beale's role as the immediate office's lead for all of OAR's international work — highlighted the fact that Beale had "lead roles in the 1990 Clean Air Act Amendments, the early implementation of the Act, the development and negotiation of the National Low Emission Vehicle Program, and the 1997 NAAQS review."³⁵⁹

Even after Beale's fraud was exposed and he pled guilty to stealing nearly one million dollars from the American people, Brenner reminded Congress of Beale's work on the NAAQS, as if it provided some sort of excuse for Beale's illegal behavior. Specifically, Brenner's written Congressional testimony stressed:

From 1995 to 1997, John played a key role in the development of new national air quality standards for ozone and particulates. John established cross-agency processes to ensure that the EPA Administrator could carefully evaluate the extensive array of health science and receive additional input from scientists and stakeholder groups outside the Agency . . . I am aware that John has recently signed a plea agreement acknowledging that he received certain salary and bonus payments from the EPA to which he was not entitled. . . . The fact that John's good works and contributions will be overshadowed by these events is unfortunate."³⁶⁰

³⁵⁸ Beale Senior Leader Application, *supra* note 6 (emphasis added).

³⁵⁹ E-mail from Gina McCarthy to Office of Air and Radiation, Env'tl. Prot. Agency (Dec. 3, 2010, 07:44 EST) (emphasis added) (on file with Committee).

³⁶⁰ Oversight & Gov't Reform Hearing, *supra* note 11 (statement of Robert Brenner) (emphasis added).

Notably, Brenner's statement was also submitted as part of Beale's leniency request to the United States District Court for the District of Columbia.³⁶¹ Lydia Wegman also submitted a letter to Judge Huvelle of the United States District Court for the District of Columbia, requesting leniency in Beale's sentence.³⁶² In her letter, she dedicates an entire paragraph to praise Beale's leadership on the NAAQS.³⁶³

Despite his allies' efforts, Beale was sentenced to thirty-six months in prison for his crimes; however, the American people have not come remotely close to being fully compensated for all of the harm caused by Beale. In the words of one former EPA official, "unfortunately, [Beale] was able to use his position to betray the public trust in a most shameful way."³⁶⁴ Accordingly, EPW Republicans are concerned by Beale's management of the 1997 Ozone and PM NAAQS and have delved deeper into the consequences flowing from the process and data behind those standards.

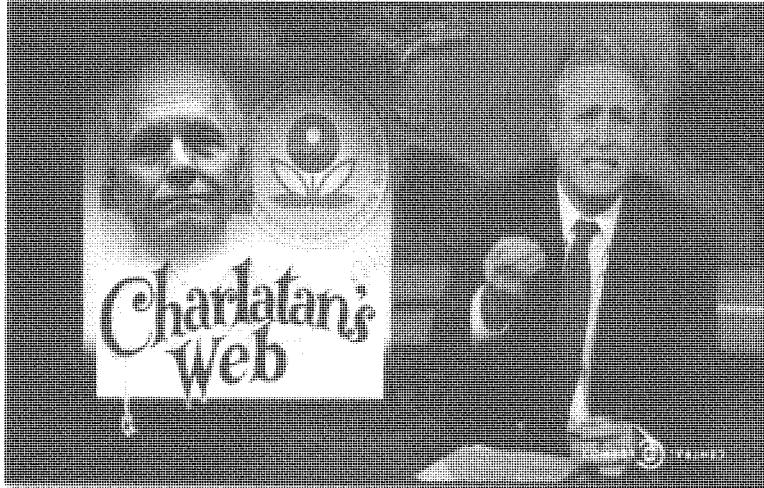


Photo from John Beale segment on *The Daily Show with Jon Stewart* (December 18, 2013).

³⁶¹ Sentencing Memorandum of John C. Beale, *supra* note 3, at Exhibit 3.

³⁶² *Id.* at 7.

³⁶³ *Id.*

³⁶⁴ *Id.* at Exhibit 2.

IV. SECRET AGENT AND SECRET SCIENCE: Still Plaguing Americans

For more than fifteen years, Congress and the American people have requested the data underlying the controversial Six Cities and ACS II studies, which served as the scientific foundation of the 1997 PM NAAQS regulation. EPA has consistently denied the public and Congress access to such data. However, EPA's basis for the vast majority of proclaimed benefits for CAA regulations are inextricably tied to these two studies and EPA has relied on updates from these same two studies to support major new CAA rules. The lack of transparency on the underlying scientific data has aggravated the questionable use of these studies in justifying EPA regulations. These issues are not isolated to EPA, as OMB currently relies on the benefits of EPA's CAA regulations, specifically the benefits of PM_{2.5} reduction, to inflate alleged benefits of all federal regulations. Accordingly, EPA continues to utilize the secret science that helped establish Beale's reputation at EPA almost twenty years ago.

a. Inflated PM_{2.5} Benefits Provide Cover for EPA's Regulatory Agenda

*"[A]s EPA has used PM_{2.5} co-benefits to justify more and more of its non-PM_{2.5} rules, it has also moved to less and less scientifically-credible methods for estimating those co-benefits. These changes in methodology and assumptions have inflated the PM_{2.5} co-benefits estimates dramatically"*³⁶⁵

— Anne E. Smith, Ph.D., NERA Economic Consulting

Since Beale's success in pushing through the Ozone and PM NAAQS in 1997, EPA has increasingly relied upon benefits derived from reductions in fine particulates (PM_{2.5}) in order to inflate benefit calculations for regulations issued under the Clean Air Act (CAA). Under Executive Orders 12866 and 13563, federal agencies must provide a regulatory impact analysis (RIA) of major regulations that includes a review of the regulation's costs and benefits.³⁶⁶ Most of these regulations are "non-PM" rules, as they directly regulate other pollutants and only impact PM_{2.5} as an ancillary matter. In such regulations, "the bulk of the benefits estimates in their RIAs are attributable to reductions in already-low concentrations of ambient PM_{2.5} that EPA has predicted will occur coincidentally as a result of regulation of those non-PM pollutant(s)."³⁶⁷ When benefits accrue coincidentally, such as PM_{2.5} reduction, from a rulemaking that was not specifically intended to create such reduction, those benefits have been deemed "co-benefits." The practice of using these co-benefits to inflate RIAs has been a key tactic used to execute the Obama Administration's regulatory agenda.

³⁶⁵ ANNE E. SMITH, NERA ECONOMIC CONSULTING, AN EVALUATION OF THE PM_{2.5} HEALTH BENEFITS ESTIMATES IN REGULATORY IMPACT ANALYSES FOR RECENT AIR REGULATIONS 16 (2011), available at http://www.nera.com/nera-files/pub_ria_critique_final_report_1211.pdf.

³⁶⁶ Exec. Order No. 12,866, 3 C.F.R. 638 (1993), reprinted as amended in 5 U.S.C. § 601 app. at 88–92 (2012); Exec. Order No. 13,563, 3 C.F.R. 215 (2012), reprinted in 5 U.S.C. § 601 app. at 101–02 (2006 & Supp. V 2011).

³⁶⁷ SMITH, *supra* note 364, at 7 (emphasis added).

Historically, EPA used co-benefits in major rules as one of several benefits quantified to justify a rule in the RIA.³⁶⁸ Yet, at the beginning of the Obama Administration, there was a “trend towards almost complete reliance on PM_{2.5}-related health co-benefits.”³⁶⁹ Instead of being an ancillary benefit, EPA started using PM_{2.5} co-benefits as essentially the only quantified benefit for many CAA regulations.³⁷⁰ Indeed, “these PM_{2.5} co-benefits not only dominate the majority of RIAs for EPA’s non-PM rules, but in many cases they are the only benefit that is being quantified at all.”³⁷¹ In fact, every RIA for major air rules between 2009 and 2011 listed PM_{2.5} benefits as the sole quantified benefit, with the exception of only five rules.³⁷²

Since Beale’s success in pushing through the 1997 NAAQS, EPA has increasingly relied upon benefits from reduced PM_{2.5} to inflate the benefits of costly regulations.

The Mercury Air Toxics Standard for coal and oil fired electric generating units, otherwise known as the Utility MACT, is a key example of EPA relying on PM co-benefits to justify a recent economically significant rule.³⁷³ EPA has claimed that “its proposal [was] justified based on cost-benefit analysis because the rule will provide benefits of up to \$130 billion ever[y] year” — while PM_{2.5} reduction comprises essentially all of the quantified benefits.³⁷⁴ EPA even “admits virtually all (i.e. 99+ percent) of the estimated \$53 to \$140 billion in annual benefits are due to reductions in PM_{2.5},”³⁷⁵ while the reduction in mercury emissions accounted for only \$500,000 to \$6.1 million in benefits.³⁷⁶

The reality is that in 2012, eighty-five coal-fired power plants retired.³⁷⁷ Five times as much coal-generating capacity is expected to retire in the next six years alone,³⁷⁸ even as electric grid reliability in the Northeast became a dangerous and costly issue this winter.³⁷⁹ According

³⁶⁸ *Id.* at Figure 1.

³⁶⁹ *Id.* The only times that EPA has deviated from this trend recently “have been rules addressing greenhouse gases (GHGs) under the CAA.” *Id.*

³⁷⁰ *Id.* at 8.

³⁷¹ SMITH, *supra* note 364, at 9 (emphasis added).

³⁷² *Id.* at Figure 1.

³⁷³ National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units, 77 Fed. Reg. 9,304 (Feb. 16, 2012) (to be codified at 40 C.F.R. pts. 60, 63).

³⁷⁴ *Id.* (internal citation omitted).

³⁷⁵ *Id.* (citing ENVTL. PROT. AGENCY, REGULATORY IMPACT ANALYSIS OF THE PROPOSED TOXICS RULE: FINAL REPORT 1-1 (2011)).

³⁷⁶ *Regulating to Regulators: Enforcing Accountability in the Rulemaking Process*, CENTER FOR REGULATORY SOLUTIONS, http://centerforregulatoryolutions.org/wp-content/uploads/2014/02/Regulating-the-Regulators_Enforcing-Accountability-in-the-Rulemaking-Process1.pdf (last visited Feb. 27, 2014).

³⁷⁷ See *AEO2014 projects more coal-fired power plant retirements by 2016 than have been scheduled*, ENERGY INFO. ADMIN., <http://www.eia.gov/todayinenergy/detail.cfm?id=15031> (last visited Mar. 17, 2014).

³⁷⁸ See *id.*

³⁷⁹ See Matthew L. Wald, *Coal to the Rescue, but Maybe Not Next Winter*, N.Y. TIMES, Mar. 10, 2014, http://www.nytimes.com/2014/03/11/business/energy-environment/coal-to-the-rescue-this-time.html?_r=0.

to the American Coalition for Clean Coal Electricity (ACCCE) things are soon to get more dangerous and far worse.³⁸⁰

EPA also used PM_{2.5} co-benefits to justify imposing costly control technology under the Regional Haze rule. Regional Haze, unlike the other provisions of the Clean Air Act, deals purely with visibility impairments and not health. However, EPA officials, including Robert Brenner, have encouraged the use of PM_{2.5} co-benefits to justify requiring power plants to install excessively costly pollution control.³⁸¹ Even so, the increased cost of such controls is known to yield no perceivable visibility benefits.³⁸²

Since the 1997 Ozone and PM NAAQS, EPA has relied on supposed PM_{2.5} benefits to defend 32 major rules.³⁸³ Despite these questionable PM co-benefits, under the Obama Administration, these rules have been associated with the greatest cost on the economy, including:

- Utility MACT — EPA estimated \$9.6 billion annualized costs,³⁸⁴
- Boiler MACT — EPA estimated \$1.9 billion annualized costs,³⁸⁵ and
- Tier III Gasoline Sulfur Rule — EPA estimated \$1.5 billion annualized costs.³⁸⁶

Critically, EPW staff anticipates that EPA will also use co-benefits of supposed PM_{2.5} reduction in justifying its 2015 Ozone NAAQS, which is expected to carry an annual cost of approximately \$19 to \$90 billion.³⁸⁷

EPA has also changed the standards and formulation for determining the value of PM_{2.5} co-benefits in recent years, further distorting EPA's cost benefit analysis. In 2009, for example, EPA modified its analysis and "greatly increased those co-benefits estimates-and did so in a way that [some] consider to have no scientific credibility."³⁸⁸ This change, coupled with increased reliance on PM_{2.5} co-benefits, has caused a drastic increase in the theoretical benefits estimates for a significant share of EPA's air regulations.³⁸⁹ This strategic behavior has allowed the

³⁸⁰ Memorandum by Am. Coalition for Clean Coal Electricity, Coal Unit Shutdowns (Jan. 26, 2014), available at http://www.cleancoalusa.org/sites/all/files/Coal_Unit_Retirements_JAN_26_2014.pdf.

³⁸¹ E-mail from Robert Brenner to Janet McCabe (Aug. 4, 2011 10:22 EST) (on file with Committee).

³⁸² WILLIAM YEATMAN, U.S. CHAMBER OF COMMERCE, EPA'S NEW REGULATORY FRONT: REGIONAL HAZE AND THE TAKEOVER OF STATE PROGRAMS 7 (2012).

³⁸³ See Appendix A (list of rules).

³⁸⁴ National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units, 77 Fed. Reg. at 9,304.

³⁸⁵ National Emission Standards for Hazardous Air Pollutants for Area Sources: Industrial, Commercial, and Institutional Boilers 76 Fed. Reg. 15,554, 15,582 (Mar. 21, 2011) (to be codified 40 C.F.R. pt. 63).

³⁸⁶ Control of Air Pollution From Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards, 78 Fed. Reg. 29,816 (proposed May 21, 2013) (to be codified at various pts. of 40 C.F.R.).

³⁸⁷ NAM D. PHAM & DANIEL J. IKENSON, NDP CONSULTING, A CRITICAL REVIEW OF THE BENEFITS AND COSTS OF EPA REGULATIONS ON THE U.S. ECONOMY 13 (2012), available at <http://www.nam.org/~media/423A1826BF0747258F22BB9C68E31F8F.ashx>.

³⁸⁸ *Quality Science for Quality Air: Hearing Before the Subcomm. on Energy and the Env't of the H. Comm. on Sci., Space, & Tech.*, 112th Cong. 5 (2011) (statement of Anne E. Smith).

³⁸⁹ *Id.*

Administration to disregard the high cost of CAA regulations as they are seemingly justified by inflated benefits.³⁹⁰

EPA is not the only federal agency taking advantage of PM_{2.5} co-benefits. The Office of Management and Budget (OMB) has routinely provided inflated analysis to Congress of the net benefits and costs of agency regulations, by not properly addressing the inflated use of PM_{2.5} co-benefits. Specifically, OMB's annual report to Congress on the costs and benefits of federal regulations has increasingly relied on PM_{2.5} reductions to justify burdensome rules.

Prescribed by statute, OMB must provide Congress an annual report on the costs and benefits, including quantifiable and non-quantifiable effects, of federal regulations.³⁹¹ In its most recent report, OMB found that "the rules with the highest benefits and the highest costs, by far, come from the Environmental Protection Agency and in particular its Office of Air and Radiation."³⁹² OMB estimated that EPA's Office of Air and Radiation accounted for nearly \$109.4 to \$629.1 billion in benefits compared to \$29.4 to \$35.3 billion in costs.³⁹³ OMB also found that EPA rules over the past ten years, "account for 58 to 80 percent of the monetized benefits and 44 to 54 percent of the monetized costs" of all federal regulations.³⁹⁴ In 2012 alone, EPA was by far the largest contributor of benefits and costs related to major regulations.³⁹⁵ For example, OMB highlighted that EPA issued three rules totaling \$28.5 to \$77 billion in benefits and \$8.3 billion in costs.³⁹⁶ In comparison, the Department of Energy recorded the next highest balance of benefits and costs with two rules totaling \$1.8 to \$3.4 billion in benefits and \$0.3 billion to \$0.7 billion in costs.³⁹⁷

OMB recognizes that these air rule benefits are "mostly attributable to the reduction in public exposure to a single air pollutant: fine particulate matter" or PM_{2.5}.³⁹⁸ However, "PM_{2.5} benefits . . . figure prominently in regulations whose purpose is not to reduce PM_{2.5}," and OMB has acknowledged that these co-benefits may inflate benefit estimates.³⁹⁹ Further, in 2008, 2010, and 2012 "co-benefits comprise[d] over 50 percent of total benefits . . . and appear to be growing in prominence" under the Obama Administration.⁴⁰⁰ Susan Dudley, former Administrator of the Office of Information and Regulatory Affairs within OMB revealed:

³⁹⁰ OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, 2013 DRAFT REPORT TO CONGRESS ON THE BENEFITS AND COSTS OF FEDERAL REGULATIONS AND AGENCY COMPLIANCE WITH THE UNFUNDED MANDATES REFORM ACT 18 (2013), available at

http://www.whitehouse.gov/sites/default/files/omb/inforeg/2013_cb/draft_2013_cost_benefit_report.pdf.

³⁹¹ Consolidated Appropriations Act of 2001, Pub. L. No. 106-554, § 624, 114 Stat. 2763, 2763A-161-62.

³⁹² 2013 DRAFT REPORT TO CONGRESS ON THE BENEFITS AND COSTS OF FEDERAL REGULATIONS AND AGENCY COMPLIANCE WITH THE UNFUNDED MANDATES REFORM ACT, *supra* note 389, at 14

³⁹³ *Id.* at 13

³⁹⁴ *Id.* at 14.

³⁹⁵ *Id.* at 22.

³⁹⁶ *Id.* at Table 1-4. Additionally, EPA issued a joint rule with the Department of Transportation accounting for the second largest amount of benefits and costs.

³⁹⁷ *Id.*

³⁹⁸ *Id.*

³⁹⁹ Susan E. Dudley, *OMB's Reported Benefits of Regulation: Too Good to Be True?*, REGULATION, Summer 2013, at 28.

⁴⁰⁰ *Id.*

In 2008, 2010, and 2012 in particular, co-benefits from PM_{2.5} reductions represent significant portions of total upper bound benefits (in 2008, the NAAQS for another criteria pollutant, ozone, derived over 70 percent of its benefits from reductions in PM_{2.5}). In 2010, four regulations claimed 100 percent of their benefits from ancillary reductions in PM_{2.5}. . . . In 2012, 99 percent of the reported benefits from the EPA's mercury and air toxics rules . . . were co-benefits.⁴⁰¹

Dudley explained that “OMB’s role is to serve as a check against agencies’ natural motivation to paint a rosy picture of their proposed action.”⁴⁰² However, it appears that OMB, while acknowledging problems associated with the use of co-benefits, has nonetheless endorsed and perpetuated EPA’s inflationary practice. The OMB has essentially codified the efforts of Beale and Brenner. In doing so, the Administration hides the true costs of EPA regulations and undermines the legitimacy of the costs and benefits of all federal regulations. Importantly, nearly all these benefits are calculated using the same underlying data from the original two studies Beale and Brenner used to justify the 1997 NAAQS for PM and ozone. They are the exact same studies that remain hidden from independent analysis almost 20 years later.

b. EPA Continues to Shield Secret Science

“The main sticking point in the current standoff between [Congress] and the EPA appears to involve the protection of subject confidentiality. . . . In fact, the issue of confidentiality appears to be a dodge.”⁴⁰³

– Dr. Geoffrey Kabat, Senior Epidemiologist, Albert Einstein College of Medicine

The Six Cities and ACS II studies provided not only the backbone for EPA’s 1997 Ozone and PM NAAQS,⁴⁰⁴ they continue to be the basis for EPA’s claimed benefits for almost every subsequent major regulation under the CAA.⁴⁰⁵ In response to the continued reticence by the Clinton Administration’s EPA to publicly release the underlying data to the Six Cities and ACS II studies, Congress passed the Shelby Amendment, a rider to the Fiscal Year 1999 Omnibus Appropriations Act.⁴⁰⁶ Upon passage, the Shelby Amendment granted the federal government the right to “obtain, reproduce, publish or otherwise use the data produced from a federal grant [and to] authorize others to receive, reproduce, publish, or otherwise use” such data for federal

⁴⁰¹ *Id.*

⁴⁰² *Id.* at 30.

⁴⁰³ Geoffrey Kabat, Op-Ed., *What Is Really At Stake In The House Committee on Science, Space, and Technology Subpoena Of EPA Data*, FORBES, Sept. 23, 2013, <http://www.forbes.com/sites/geoffreykabat/2013/09/23/what-is-really-at-stake-in-the-republican-partys-subpoena-of-epa-data/>.

⁴⁰⁴ See INNOVATIVE STRATEGIES & ECON. GRP., OFFICE OF AIR QUALITY PLANNING & STANDARDS, ENVTL. PROT. AGENCY, REGULATORY IMPACT ANALYSES FOR THE PARTICULATE MATTER AND OZONE NATIONAL AMBIENT AIR QUALITY STANDARDS AND PROPOSED REGIONAL HAZE RULE (1997), available at <http://www.epa.gov/ttn/oarpg/naaqsfir/ria.html>.

⁴⁰⁵ *Id.*

⁴⁰⁶ Data Access Act, Pub. L. No. 105-277, tit. III, 112 Stat. 2681, 2681-495 (1998).

purposes.⁴⁰⁷ Moreover, the Shelby Amendment mandated that OMB amend Circular A-110 to require federal agencies to ensure that “all data produced under a [federally funded] award be made available to the public through the procedures established under FOIA.”⁴⁰⁸

On October 8, 1999, OMB published its final version of Circular A-110 regarding public access to scientific data underlying agency rule makings.⁴⁰⁹ This Circular implemented and interpreted the provisions of the Shelby Amendment, and dealt with the definition of several ambiguous terms including the meaning of “data,” “published,” and “used by the federal government in developing an agency action that has the force and effect of law.”⁴¹⁰ The effective date was November 8, 1999, and has not been changed in subsequent updates to the circular.⁴¹¹

Despite the enactment of the Shelby Amendment, EPA continued to thwart public access to the underlying data for the two health studies. In its comment on OMB’s proposed changes to Circular A-110, EPA’s Deputy Associate General Counsel, Howard Corcoran, asserted that EPA’s interpretation of the Shelby Amendment did not require EPA to make data available even if it was the result of federal grants, if the researchers relied on any amount of private funding.⁴¹² Interestingly, Mr. Corcoran soon thereafter took over the EPA’s office handling grants to the scientific community.⁴¹³

The same EPA official who argued that the Shelby Amendment did not apply to mixed-funding grants, is now EPA’s gatekeeper for grants.

In January 2000, EPA rejected a Chamber of Commerce FOIA request to access the data behind the Six Cities study.⁴¹⁴ In denying this request, Lydia Wegman, Beale’s ally in the NAAQS process, advanced a legal interpretation on behalf of EPA that the Shelby Amendment did not retroactively apply to rules issued before its enactment.⁴¹⁵ Moreover, Wegman explained that because EPA relied on the findings of the study, rather than the underlying health surveys,

⁴⁰⁷ OMB Circular A-110, “Uniform Administrative Requirements for Grants and Agreements With Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations” 64 Fed. Reg. 54,926, 54,930 (Oct. 8, 1999) (codified at 2 C.F.R. § 215.36(c)(1) (2013)).

⁴⁰⁸ Data Access Act, 112 Stat. at 2681-495.

⁴⁰⁹ OMB Circular A-110, 64 Fed. Reg. at 54,926.

⁴¹⁰ *Id.* at 54,930.

⁴¹¹ 2 C.F.R. § 215.36.

⁴¹² Comment by Envtl. Prot. Agency, Against proposed revision to OMB Circular A-110 (Apr. 5, 1999), available at <http://www.thecre.com/ipd/access/agency/1999-04-05f.html>.

⁴¹³ *Id.* Corcoran had been working in the Office of General Counsel under the Grants Law Division since 1988. See MGMT. & ORG. DIV., OFFICE OF ADMIN., ENVTL. PROT. AGENCY, WHO’S WHO IN EPA: ORGANIZATION CHARTS AND LISTING OF PRINCIPAL OFFICERS 22 (Oct. 1998 ed.). Beginning in 2001, he became the Director of the Grants Office, see CARROLL’S FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 580 (Nov./Dec. 2001 ed.), and is still there today. See FEDERAL DIRECTORY: EXECUTIVE, LEGISLATIVE, JUDICIAL 488 (Summer 2013 ed.).

⁴¹⁴ Letter from Lydia Wegman, Dir., Air Quality Strategy and Standards Div., Envtl. Prot. Agency, to William Kovacs, Vice President, Envtl. & Regulatory Affairs, U.S. Chamber of Commerce 2-3 (Jan. 21, 2000), available at http://insideepa.com/index.php?option=com_iwpfile&file=/iwpextra/ee00073.pdf.

⁴¹⁵ *Id.* at 1.

the Agency did not have the underlying data in its possession.⁴¹⁶ Wegman also asserted that the participants in the survey were guaranteed privacy.⁴¹⁷ An OMB review of FOIA requests from 1999 to August 31, 2003, citing the Shelby Amendment found that EPA denied “requests it received because the requested data were generated by projects funded prior to the effective date of its regulation implementing the revision to OMB Circular A-110.”⁴¹⁸

The Agency, both by action and inaction, continually denied Congress and taxpayers their right to data used to justify costly air regulations, contrary to both statutory and OMB requirements. Accordingly, Congress has continued to request the data underlying these studies be made available to Congress and the public. In 2000, HEI finally completed its reanalysis of the Six Cities and ACS II studies, as a substitute for the full release of the data.⁴¹⁹ However, HEI did not have access to all original data, inputs, or outputs. Rather they worked with the original authors to replicate the studies, truncating their ability to perform an effective review. In 2004, the National Research Council issued a report that recommended that EPA discontinue relying on the two data sets.⁴²⁰

Since 1997, serious questions have been raised about the quality of the data, the validity of their use, and the perpetual refusal by EPA — and the researcher institutions — to be transparent with the science so that it could be independently reanalyzed. More than 15 years later, the nominee to be EPA Administrator, Gina McCarthy, would echo Carol Browner’s assertion that only “legitimate scientists” would be given access to the underlying data during her discussions with Senator David Vitter, just prior to a months-long battle to force the Agency to finally acquire and turn over the data for independent reanalysis.⁴²¹ 2013 would turn out to be the most significant year in nearly two decades for uncovering the depth at which the EPA, as well as Harvard and ACS, would go to prevent the public from acquiring or otherwise independently verifying the quality of their secret data.

⁴¹⁶ *Id.* at 2–3.

⁴¹⁷ *See id.* at 3.

⁴¹⁸ GOV’T ACCOUNTABILITY OFFICE, GAO-04-31, UNIV. RESEARCH: MOST FED. AGENCIES NEED TO BETTER PROTECT AGAINST FIN. CONFLICTS OF INTEREST 21–22 (2003), *available at* <http://www.gao.gov/assets/250/240568.pdf> (demonstrating that EPA requests included an attempt to access the data underlying the Harvard Six Cities Study).

⁴¹⁹ DANIEL KREWSKI ET AL., HEALTH EFFECTS INST., REANALYSIS OF THE HARVARD SIX CITIES STUDY AND THE AMERICAN CANCER SOCIETY STUDY OF PARTICULATE AIR POLLUTION AND MORTALITY (July 2000), *available at* <http://pubs.healtheffects.org/getfile.php?u=274>.

⁴²⁰ *See* COMM. ON RESEARCH PRIORITIES FOR AIRBORNE PARTICULATE MATTER, NAT’L RESEARCH COUNCIL, RESEARCH PRIORITIES FOR AIRBORNE PARTICULATE MATTER: IV. CONTINUING RESEARCH PROGRESS (2004).

⁴²¹ Meeting between Gina McCarthy and Sen. Vitter (Mar. 20, 2013).

c. Congress Fights for Transparency and Access to Secret Science

“For years EPA has stonewalled Congress and the American public from gaining access to the research behind a number of significant air regulations. The Agency’s excuses for failing to be transparent are wearing thin, and the underlying data needs to be made available so there can be independent reanalysis.”⁴²²

– Senator David Vitter, Ranking Member, Committee on Environment and Public Works

As Ranking Member of the EPW Committee, Senator Vitter, along with his EPW Republican colleagues made transparency, including data access, a priority throughout the confirmation process for EPA Administrator nominee, then-AA for OAR, Gina McCarthy.⁴²³ On March 4, 2013, Senator Vitter, along with Chairman Smith, sent a letter to McCarthy, seeking the science underpinning new air quality rules and criticizing the agency's lack of transparency and use of secret data.⁴²⁴ The letter pointed out that “high-ranking Administration officials have repeatedly backtracked and reneged on promises to Members of Congress to make the scientific information that underpins the Agency’s basic associations between air quality and mortality available to the public and independent scientists over the last year and a half,” further stating that “not only do these assumed relationships provide the scientific building blocks of virtually all air quality regulations that you have pursued,” but “they also provide a disproportionately significant role in claimed regulatory benefits across the federal government.”⁴²⁵

In response, EPA re-sent inadequate data previously provided to Congress, even while admitting that the data provided were not sufficient to replicate analysis. Furthermore, the Agency echoed the same argument made by former AA for OAR, Mary Nichols, during the 1997 PM and Ozone NAAQS controversy, arguing that the complete set of data underlying the studies is not held by EPA; rather, it is held by the scientific researchers that conducted the relevant research.⁴²⁶

On April 8, 2013, EPW Republicans reiterated their overarching concerns with EPA’s reliance on particular health studies to show that certain pollutants cause chronic mortality, and to calculate extraordinarily high benefit estimates to justify a number of costly CAA regulations.⁴²⁷ In the weeks leading up to April 10, 2013, the EPW Republicans, continued

⁴²² Press Release, S. Comm. on Env’t & Pub. Works Minority Office, Vitter Pushes for Resolution of “Secret Science” Behind Expensive EPA Air Rules (Mar. 17, 2014), available at http://www.epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=28fbca8b-bfe1-6d91-5ec8-da554f9fa85f.

⁴²³ See *Hearing on the Nomination of Gina McCarthy to be Administrator of the U.S. Environmental Protection Agency Before the S. Comm. on Env’t & Pub. Works*, 113th Cong. (2013).

⁴²⁴ Letter from Sen. Vitter & Rep. Lamar Smith, Chairman, H. Comm. on Sci., Space, & Tech., to Gina McCarthy (Mar. 4, 2013), available at http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=f840b59e-c614-4ea2-b6a0-a9b16655b982.

⁴²⁵ *Id.* at 1.

⁴²⁶ Letter from Bob Perciasepe to Sen. Vitter 2 (May 1, 2013) (on file with Committee).

⁴²⁷ See Press Release, S. Comm. on Env’t & Pub. Works Minority Office, Eye on the EPA: Failure to Share Scientific Data with Congress, American Public (Apr. 8, 2013), available at

negotiations over McCarthy's confirmation, and remained focused on increasing transparency at the EPA.⁴²⁸ A key component of the negotiations: EPA needed to finally turn over the data — coded to mitigate disclosure of confidential information — from the Six Cities study, the ACS study, and additional research based on that data. Specifically, EPA was to release the full set of data files for the ACS study and the Six Cities study as well as the underlying data from additional long term cohort studies that relied on updates from the Six Cities and ACS studies, including: Krewski et al. (2009); Pope et al. (2002); Pope et al. (2009); Krewski et al. (2000); Laden et al. (2006); and Lepeule et al. (2012).

One of EPA's excuses for preventing release of the data was it contained personally identifiable information and could jeopardize the confidentiality of individuals that participated in the studies. However, from day one of the McCarthy negotiations, EPW Republicans made clear their request included the coding of Personal Health Information (PHI) to protect the identity of individuals included in the decades-old data sets. This is not a novel undertaking as the U.S. Department of Health and Human Services recently issued guidelines on how to de-identify medical records in order to implement elements of the new healthcare law. In addition, EPA itself worked with the Centers for Disease Control and Prevention (CDC) to remove personal identifiers from data provided by Harvard University and released information on deaths originally obtained from the National Death Index (NDI), providing evidence that data containing personal information can be de-identified and released.

Moreover, many of the input files to the models do not contain confidential information. This was confirmed by HEI in its 2000 reanalysis report,⁴²⁹ as the authors noted that certain input files (notably the Mor6C.file) "did not contain any information that could be used to identify the individual study participants."⁴³⁰ The input and output files are fundamental to conducting reanalysis, so Congress repeatedly requested that EPA: (1) obtain all the data files; (2) determine which data files pose a threat to privacy; (3) immediately release all data files that do not pose a threat to privacy; and (4) investigate measures to remove all personal health information from the files that contain confidential data prior to release. However, EPA outright failed to obtain the full universe of data underlying these studies in spite of legal requirements and Congressional requests.

Another excuse EPA advanced was that it was unwilling to obtain and release certain data because the research was funded through a mixture of public and private money. However, OMB's Circular A-110 made clear that the data access provisions apply to mixed (public/private) funding research efforts, as "the amended Circular shall apply to all Federally-

www.epw.senate.gov/public/index.cfm?FuseAction=Minority.Blogs&ContentRecord_id=eb0a2a04-0e21-b220-1af2-61f5a501d46e&Region_id=&Issue_id=

⁴²⁸ See Press Release, S. Comm. on Env't & Pub. Works Minority Office, Vitter, EPW Committee Republicans Release Requests for Gina McCarthy (Apr. 10, 2013), *available at* www.epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=f52a53ab-faa7-77e3-2e57-df15459b241b&Region_id=&Issue_id=

⁴²⁹ See KREWSKI ET AL., *supra* note 418.

⁴³⁰ *Id.* at 42.

funded research, regardless of the level of funding or whether the award recipient is also using non-Federal funds.”⁴³¹ Accordingly, EPA's mixed funding excuse contradicts OMB's guidance.

On May 9, 2013, the EPW Republicans boycotted the Committee nomination vote of McCarthy. The boycott was specifically related to the lack of transparency at the Agency, and in significant part to the EPA failing to uphold its agreement to finally acquire and release the underlying data to the key studies. In committing to the boycott, Senator John Barrasso (R-WY), said:

The new nominee to be EPA Administrator has been extremely unresponsive with the information we requested. We're not asking to amend any bedrock environmental laws. We're asking for access to the scientific data and reasoning behind the justification for expensive new rules and regulations that continue to cause high unemployment. We're simply requesting that Ms. McCarthy and this Administration honor its commitment to transparency—that's what they promised.⁴³²

In a letter dated June 12, 2013, EPW Republicans reiterated their request for the underlying data, saying, “EPA has continually refused to make public the basic scientific data underlying virtually all of the Agency's claimed benefits from Clean Air Act rules. Everyone agrees on the importance of clean air, but EPA needs to release the secret data they use in formulating rules.”⁴³³ In addition, the letter highlighted:

The EPA's new Clean Air regulations, including the upcoming ozone standard, are expected to be some of the most costly the federal government has ever issued. Relying on secret data to support these rules is not acceptable. The public and outside scientists must be able to independently verify the EPA's claims, especially when the results are contradicted by so many other studies.⁴³⁴

Finally, on July 9, 2013, the EPA acquiesced to EPW Republicans' transparency requests, including initiating the process of acquiring and turning over the data available to the Agency. EPW Republicans agreed to stop blocking nominee McCarthy in exchange for EPA initiating the process of obtaining the requested scientific information, as well as reaching out to relevant institutions for information on how to de-identify and code personally identifying information from any of the data the institutions and the Agency continued to withhold. The agreement included the understanding that for the first time outside verification would be possible so as to permit independent re-analysis of the benefits claims for a suite of major air regulations developed under the system established by Brenner and Beale.

⁴³¹ OMB Circular A-110, “Uniform Administrative Requirements for Grants and Agreements With Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations,” 64 Fed. Reg. 5,684, 5,684 (Feb. 4, 1999).

⁴³² Press Release, S. Comm. on Env't & Pub. Works Minority Office, EPW Committee Delays Gina McCarthy Nomination Vote (May 9, 2013), *available at* http://www.epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=8aae983e-cb8e-03f6-0743-ce4913c8ca7e.

⁴³³ Press Release, S. Comm. on Env't & Pub. Works Minority Office, Vitter Reiterates Request for Release of EPA Secret Data (June 12, 2013), *available at* http://www.epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=3933c47c-beda-3e56-0923-e866c7879b04.

⁴³⁴ *Id.*

On August 1, 2013, after two years of requests, Chairman Lamar Smith (R-TX) of the House of Representatives Committee on Science, Space, and Technology (House SST Committee) subpoenaed EPA for essentially the same datasets EPW Republicans negotiated to receive from the Agency.⁴³⁵ On August 21, 2013, pursuant to the agreement regarding McCarthy's confirmation, EPW Republicans received the first tranche of scientific data in what was anticipated to be a series of responses from EPA.⁴³⁶ Over a period of several months, the EPA transferred data as they acquired it to both the Senate EPW Committee and the House SST Committee. Despite the House SST Committee issuing a subpoena, the data provided to both Committees was identical. Coincidentally, the eventual release of such data occurred around the same time EPW Republican staff learned of Beale's decades-long fraud against EPA and American taxpayers.

After fifteen years of delays and excuses, EPA finally reached out to the institutions (ACS, Harvard, and HEI) to request data, as well as solicit advice on possible coding techniques. EPA waited nearly three months to turn over the institutions' responses to its inquiry. EPA's cover letter to EPW Republicans once again listed all the same reasons why EPA — and by extension, the institutions — would not be able to transfer all the data despite the House SST Committee subpoena and EPW Republicans' agreement on McCarthy. The list of excuses are familiar: the data sets are not held or owned by the EPA,⁴³⁷ the institutions will not release complete, unmodified datasets because of concerns about confidential personal health information;⁴³⁸ and that the datasets are only available for legitimate scientists to apply for access to through the institutions.⁴³⁹

Individually, ACS disapproved of Congress's interest in accessing the data for independent verification,⁴⁴⁰ and HEI illustrated reasons why the datasets, if stripped of confidential information, would be insufficient for full replication.⁴⁴¹ Harvard echoed HEI, while also pointing out, "A great deal of time has elapsed since data collection began in these long-term air pollution studies. Existing electronic data from the early years of the HSC study may have deteriorated, or may be stored on media that cannot now be read or deciphered by any available devices or software."⁴⁴² Accordingly, EPA, Harvard and ACS, have stated the data supporting these studies, which led to the creation and implementation of major CAA rules, either no longer exists, is of such poor quality that modeling results cannot be replicated, or has yet to go through de-identification of the data so as to facilitate independent analysis.

⁴³⁵ See Resolution Offered by Rep. Smith, H. Comm. on Sci, Space, & Tech., 113th Cong. (2013) (enacted).

⁴³⁶ Press Release, S. Comm. on Env't & Pub. Works Minority Office, EPA Takes First Steps in Acquiring and Releasing Secret Data (Aug. 21, 2013), available at http://www.epw.senate.gov/public/index.cfm?FuseAction=PressRoom.PressReleases&ContentRecord_id=A122774F-A015-51D8-A7EE-8954668ABECD.

⁴³⁷ Letter from Lek Kadeli, Principal Deputy Assistant Adm'r, Office of Research & Dev., Envtl. Prot. Agency, to Sen. Vitter 2 (Oct. 30, 2013) (on file with Committee).

⁴³⁸ *Id.*

⁴³⁹ *Id.*

⁴⁴⁰ See Letter from Otis W. Brawley, Chief Med. Officer & Exec. Vice-President for Research & Cancer Control Sci., Am. Cancer Soc., to Lek Kadeli (Aug. 19, 2013) (on file with Committee).

⁴⁴¹ See Letter from Daniel S. Greenbaum, President, Health Effects Inst., to Lek Kadeli (Aug. 27, 2013) (on file with Committee).

⁴⁴² Letter from Catherine Breen, Senior Dir., Office for Sponsored Program, Harvard University, to Lek Kadeli 2 (Sept. 25, 2013) (on file with Committee).

On March 11, 2014, Senator Vitter sent a letter to the EPA inquiring on the status of de-identifying the datasets.⁴⁴³ EPA should have taken critical steps to implement one of the numerous options for protecting personal health information. Currently, it should be possible to independently analyze all of EPA's health benefits claims as there should no longer be any excuse for withholding data from the public — particularly the excuses related to personal health information.

Although EPA is supposed to be adopting recommendations for de-identifying data to mitigate any sharing of personal health information pursuant to their agreement with EPW Republicans, it appears that Congress has acquired either all the data that still exists, or all data the institutions are willing to provide for fear of their data being discredited. Congress has received written confirmation from several scientists that attest to the fact that there exists no way to reanalyze the data provided thus far by the EPA.⁴⁴⁴ There continues to be no opportunity for independent scientific scrutiny of the conclusions EPA has made on major air regulations based on the data utilized from the time both Brenner and Beale were at the EPA.

In light of continued concerns, on March 17, 2014, Senator Vitter sent a letter to Dr. Francesca Grifo, EPA's Scientific Integrity Official, regarding concerns with EPA continuing to violate the Organization for Co-operation and Economic Development's (OECD) guidelines for "Best Practices for Ensuring Scientific Integrity and Preventing Misconduct."⁴⁴⁵ The letter particularly focused on data-related misconduct ("not preserving primary data," "bad data management, storage," "withholding data from the scientific community") and outlining the serious concern that Harvard, American Cancer Society, the researchers, and the EPA were likely responsible for similar data-related misconduct as an OECD member country.

⁴⁴³ Letter from Sen. Vitter to Bob Perciasepe (Mar. 11, 2014), *available at* http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=6de2a2b9-ad38-41bc-a0c4-c909b391a526.

⁴⁴⁴ *See, e.g.*, Letter from Julie E. Goodman, Principal, Gradient Corp., to Sen. Vitter, Harvard Six Cities and American Cancer Society Cancer Prevention II Study Data (Mar. 17, 2014) (on file with Committee); Letter from Stanley Young, Assistant Dir. for Bioinformatics, Nat'l Inst. of Statistical Sciences, to Sen. Vitter (Mar. 7, 2014) (on file with Committee); Letter from Michael Honeycutt, Dir., Toxicology Div., Tex. Comm'n on Env'tl. Quality, to Rep. Smith (Nov. 8, 2013) (on file with Committee).

⁴⁴⁵ Letter from Sen. Vitter, to Dr. Francesca Grifo (March 17, 2014), *available at* http://www.epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=28fbcaf8-bfe1-6d91-5ec8-da554f9fa85f.

CONCLUSION

The legacy of John Beale and his best friend Robert Brenner is a permanent tarnishing of the concept of public service as it is executed at Environmental Protection Agency (EPA). In sharp contrast to the ideal neutral, non-biased, highly specialized public servant, Beale's lack of training on the environment, economics, or science meant he did not have the competency to make the important judgment calls that the Agency delegated to him. By putting him in charge of critical and highly technical issues, it appears the EPA valued political outcomes above all else and abandoned a deliberate science-based process to create policies that best serve the public. In his personal fraud, Beale took advantage of his stature at the Agency and acted selfishly to advance his own personal agenda. In his professional capacity, Beale, along with certain EPA career staff, executed a similar strategy to accomplish the singular goals of extreme environmentalists. Disturbingly, Beale was lionized by career staff that witnessed and aided him in his efforts and was rewarded by his superiors. Beale received an excessive retention bonus and pay in excess of the statutory threshold because of the value EPA placed on the work he did on the 1997 National Ambient Air Quality Standards (NAAQS). Even when his web of lies began to disintegrate, his coworkers stuck their heads in the sand, refusing to acknowledge the painfully obvious fact that their hero was nothing more than a fraudster.

It is now clear that Beale, a convicted con artist, was a central player in one of EPA's most significant rulemakings, the 1997 NAAQS for Ozone and Particulate Matter (PM). This effort codified EPA's now customary practice of using fine particulates (PM_{2.5}) to inflate the benefits of nearly all regulations issued under the Clean Air Act. Yet the science supporting nearly all of EPA's alleged benefits remain hidden and unverified. Moreover, Beale and Brenner introduced a series of actions that collectively comprise what this report refers to as "EPA's Playbook" for pushing through controversial rulemakings. These actions include a heavy handed managing of the interagency review process in a way that compresses timelines through sue-and-settle agreements and deprives other stakeholders of the necessary time to conduct meaningful analysis; it is an outcome driven strategy, not one based in science; and whose ends justify whatever means are necessary to push through EPA staffs' desired outcome.

Since the Obama Administration assumed power, EPA's Playbook has been resurrected and implemented with zeal with dire consequences for some Americans. On March 10, 2014, *The New York Times* reported on the story of an 81-year-old Ernestine Cundiff of Columbus, Ohio, a diabetic with deteriorating health, living on a fixed income. Ms. Cundiff now struggles to pay her energy bills as a result of EPA air regulations that have shut down electricity generation in her part of the country. As the *Times* notes, situations like Ms. Cundiff's, "although particularly acute in the Northeast . . . ha[ve] spread to other regions of the country." It will continue to spread as EPA's efforts close scores of power plants, which negatively affects struggling Americans. According to the American Coalition for Clean Coal Electricity, EPA's draconian policies will force over 330 electric generating units to close or to be retrofitted with expensive conversions. The people impacted by these closures are everyday Americans like Ms. Cundiff, and so the legacy of John Beale lives on at EPA even though the man himself is currently behind bars.

APPENDIX A

EPA Regulations Justified by PM 2.5 Benefits Since 1997		
Year	Rule	FR Citation
1999	Regional Haze Standards	64FR35714
2000	Control of Air Pollution From New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements	65FR6698
2001	Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements	66FR5001
2004	Interstate Ozone Transport: Response to Court Decisions on the NOX	69FR21603
2004	Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel	69FR38957
2005	Rule To Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule); Revisions to Acid Rain Program; Revisions to the NOX	70FR25162
2005	National Emission Standards for Hazardous Air Pollutants: Final Standards for Hazardous Air Pollutants for Hazardous Waste Combustors (Phase I Final Replacement Standards and Phase II)	70FR59402
2005	Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations	70FR39137
2006	Standards of Performance for Stationary Compression Ignition Internal Combustion Engines	71FR39154
2006	National Ambient Air Quality Standards for Particulate Matter	71FR61144
2007	Control of Hazardous Air Pollutants From Mobile Sources	72FR8428
2007	Clean Air Fine Particle Implementation Rule	72FR20586
2008	National Ambient Air Quality Standards for Ozone	73FR16436
2008	Control of Emissions of Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder	73FR25098
2008	Control of Emissions From Nonroad Spark-Ignition Engines and Equipment	73FR59034
2008	National Ambient Air Quality Standards for Lead	73FR66964
2010	National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines	75FR9648
2010	Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder	75FR22896
2010	Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule	75FR25324
2010	Primary National Ambient Air Quality Standard for Sulfur Dioxide	75FR35520
2010	National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines	75FR51570
2010	National Emission Standards for Hazardous Air Pollutants From the Portland Cement Manufacturing Industry and Standards of Performance for Portland Cement Plants	75FR54970
2011	NSPS/Emission Guidelines (EG) for Sewage Sludge Incinerators	76FR15372
2011	NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters	76FR15608
2011	NESHAP for Area Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters	76FR15554
2011	Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Commercial and Industrial Solid Waste Incineration Units	76FR15704
2011	Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals	76FR48207
2011	Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles	76FR57105
2012	National Emission Standards and Standards of Performance: Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units	77FR9304
2012	Standards of Performance for Petroleum Refineries; Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007 (amendments of June 24, 2008 final rule)	77FR 56422
2012	2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards (joint rule with NHTSA)	77FR 62624
2013	National Ambient Air Quality Standards for Particulate Matter	78FR3085

Senator VITTER. The Obama EPA has embraced the strategies of this playbook and pursued ideologically driven agendas in much the same way as Beale did in the 1990s, pushing through controversial regulations where the ends justify the means. This is done by assenting to sue and settle agreements, excluding public participation, employing heavy handed management of the inter-agency review process, inflating purported benefits, and, quite frankly, just hiding science.

EPA's continued use of the playbook has led to dire consequences for Americans. For example, on March 10th of this year, the New York Times reported on the story of 81-year-old Ernestine Cundiff of Columbus, Ohio, a diabetic with deteriorating health living on a fixed income. Ms. Cundiff now struggles to pay her energy bills as a direct result of EPA air regulations that have shut down electricity generation in her part of the country.

To advance EPA's extreme agenda, it is also clear that this EPA extends its regulatory arm with complete disregard for American taxpayer dollars, and we have many examples of that.

These examples of waste and abuse make congressional oversight absolutely critical. That is why this hearing and follow up work is so enormously important to get at this concerning culture, of which, unfortunately, John Beale is just the poster child, not the full extent.

Thank you, Madam Chair.

Senator BOXER. Thanks, Senator.

I want to place in the record a counter to some of these things. An article in the Washington Post that says, outside of Gina McCarthy, there wasn't ever, ever, in all the years under the Bush administration, Republican and Democratic administrations, no one ever stopped Beale except Gina McCarthy. We will put that in the record and we will call on Senator Whitehouse.

[The referenced document follows:]

Ex-EPA official pleads guilty to theft, pretended to work for the CIA - The Washington Post

The Washington Post

[Back to previous page](#)

Ex-EPA official pleads guilty to theft; he also had claimed to work for CIA

By **Ann E. Marinow and Lenny Bernstein**,
Published: September 27

A former high-level official at the Environmental Protection Agency admitted Friday that he stole nearly \$900,000 from the government by pretending to work for the CIA in a plea agreement that raised questions about how top agency managers failed to detect the scheme since it began in 1994.

John C. Beale duped a series of supervisors, including top officials of the EPA's Office of Air and Radiation, disappearing from the office and explaining his absences by telling his bosses that he was doing top-secret work for the CIA and its "directorate of operations."

He lied about contracting malaria (he didn't) while he served in Vietnam (all his military service was in the United States) to obtain a parking space reserved for the disabled that cost the EPA \$8,000 over three years. He took personal trips to Los Angeles for which he charged the government more than \$57,000, according to new court filings.

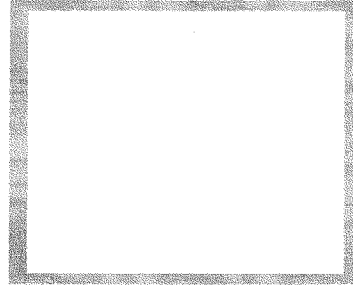
In all, Beale was paid for 2¹/₂ years of work he did not perform since early 2000 and received about \$500,000 in "retention bonuses" he did not deserve for nearly two decades, according to court papers and interviews.

"To our knowledge, prior to [current EPA Administrator] Gina McCarthy expressing her concerns, no one at EPA ever checked to see if Mr. Beale worked for the CIA," said Assistant Inspector General Patrick Sullivan, who led the investigation that included interviews of 40 people. Only one, an executive assistant, suspected Beale's story of working for the clandestine service.

Nor did EPA personnel compare Beale's travel vouchers, which said he was in places such as Boston and Seattle, with hotel receipts for the same dates that showed him in Bakersfield, Calif., where he has family.

Even during the probe, which began in March, Beale continued to insist that he could not be interviewed because of his work for the CIA, Sullivan said. Only when investigators offered to question him in a secure room at the agency's Langley headquarters did he admit he had no connection to the CIA, Sullivan said.

For reasons the EPA cannot explain, Beale continued to draw a paycheck until April 30, 19 months after his retirement



Post Most

[Final round of snow expected tonight, then chilling winds will move in](#)

[Kindergarten teacher: My job is now about tests and data -- not kids. I quit.](#)

[Spring storm lays down several inches of snow](#)

[In D.C. mayor poll, Muriel Bowser surges against wounded incumbent Vincent Gray](#)

[Dead chickens, roosters found in Rock Creek Park; police believe part of ritualistic killing](#)

Ex-EPA official pleads guilty to theft, pretended to work for the CIA - The Washington Post

dinner cruise on the Potomac River and 23 months after he announced he would retire, according to Sullivan and court documents. Beale and his attorney declined to comment after the federal court hearing Friday.

The case has attracted political attention, in part because Beale was defrauding the agency when he worked for McCarthy, the new EPA administrator, when she headed the agency's Air and Radiation office.

McCarthy started her job in 2009 and told investigators she began to suspect Beale in March 2012, Sullivan said. McCarthy, who is identified as "EPA Manager #2," in court documents, eventually discovered that Beale was still receiving a paycheck long after she helped celebrate his retirement. She became EPA administrator this year.

McCarthy referred the matter to the EPA general counsel's office. Instead of being transferred to the inspector general, it was referred to the EPA's Office of Homeland Security, which has no investigative authority. That delayed the IG's probe for months, said people familiar with the investigation.

Repeated calls and e-mails to EPA representatives were not returned Friday.

The top Republican on the Senate Environment and Public Works Committee, David Vitter (La.), said Friday that the case highlights a "major failing within EPA" and that "no direct actions have been taken to guarantee this kind of abuse won't happen again."

The committee's chairman, Barbara Boxer (D-Calif.) called Beale's actions "outrageous" and praised the inspector general and McCarthy for "putting an end to his thievery." Boxer has scheduled a briefing for Monday. Beale is scheduled to appear at a [House Committee on Oversight and Government Reform](#) hearing next week titled "Secret Agent Man?"

Beale, 64, was charged in August with stealing \$886,186 in pay and bonuses. A senior policy adviser in the Air and Radiation office, he earned \$164,700 when he retired in April. He has repaid the \$886,186 to the EPA as part of his plea agreement but still owes a money judgment of \$507,000. Beale, who until recently lived in Arlington County, faces up to three years in prison under federal sentencing guidelines.

Even though court documents trace Beale's conduct to 2000, the IG's office found that Beale's deception began in 1989, when he falsely wrote on his employment application that he had worked for former senator John Tunney of California, Sullivan said. Tunney's name was misspelled on the form, he said. Beale said he began the CIA ruse in 1994, Sullivan said, because he missed the limelight from his work on the Clean Air Act reauthorization from 1990 to 1993.

Early on at the EPA, Beale's air-quality expertise led to many legitimate overseas trips to places such as China, South Africa and England, said people familiar with the case. His frequent international travel also allowed him to cultivate an aura of mystery, his former colleagues said.

When Beale started disappearing from the office in 2001, he told a person identified as "EPA manager #1" that he was assigned to a special advisory group working on a project with the Directorate of Operations at the CIA, according to the court filing.

The manager agreed to Beale's request to be out of the office one day a week for the CIA work, according to the statement of the offense.

In 2005, court documents say the same manager approved a long-term research project that Beale had proposed. Beale took five trips to Los Angeles to work on the project, which prosecutors said did not require travel. Beale stayed in Bakersfield and visited nearby family members. He was reimbursed more than \$57,000 in travel expenses for work that was never produced.

The inspector general's office identified "manager #1" as Jeffrey R. Holmstead, who was head of the Office of Air and Radiation from 2001 to 2005, during the administration of George W. Bush. Holmstead, a lawyer in Washington, said in an e-mail that he had "no recollection of approving [Beale's] requests."

Ex-EPA official pleads guilty to theft, pretended to work for the CIA - The Washington Post

“He did tell me that he had an assignment with the CIA that would sometimes take him out of the office, but I was never asked to approve this arrangement. Career employees are sometimes detailed to work at other agencies, and I assumed that Mr. Beale’s work at the CIA was done pursuant to such an arrangement.”

In 2008, Beale did not show up at the office for about six months, telling his managers that he was either working on a research project or for “Langley,” a reference to the CIA.

Throughout the scheme, Beale was receiving a 25 percent retention bonus that should have expired after three years, in 2003. Instead, he continued to receive the bonus through 2013, according to the court documents, and was among the highest paid, nonelected federal government employees. A close friend of Beale’s, his supervisor Robert Brenner, put him in for the bonus twice, Sullivan said.

In May 2011, Beale announced his retirement. The next month, he told McCarthy that his CIA work would keep him out of the office for long periods. Beale sent e-mails to McCarthy and others at the EPA during that time, saying he was traveling overseas and doing CIA work. In reality, Beale was at home or at his vacation house on Cape Cod, according to the plea agreement.

VISA **Black Card™**
BLACK Industry-Leading Rewards. Become an Elite Visa Black Card Member Now!
CARD BlackCard.com

Ad Choices 

Make Money With Penny Stocks
 Maryland Will this \$0.50 stock hit \$6.00? 3 reasons why we think so
 www.invests.com

Tired Of Your Job?
 Learn The Proven Way To Make \$4000.00/Month Online-Join Today!
 www.youmakethemoney.com

[Buy a link here](#)

© The Washington Post Company

**OPENING STATEMENT OF HON. SHELDON WHITEHOUSE,
U.S. SENATOR FROM THE STATE OF RHODE ISLAND**

Senator WHITEHOUSE. Thank you, Madam Chair.

And thank you, Administrator McCarthy, for being here. You exercise one of the most important responsibilities of the Federal Government, to protect human health and the environment, and I applaud your service, and I am sorry that this issue has become so partisan. I have the seat of Senator John Chafee, who was both a Republican and an environmentalist, and I am sorry that that combination of features no longer seems possible in Washington.

You have had to do more with less, and I appreciate that. There are people here who want you to do less with less. They don't want EPA to be efficient; they want it to be wounded and to be unable to protect the American public. But I urge you to continue with your work. Your Tier 3 motor vehicle rule, for instance, will prevent as many as 2,000 premature deaths and 30,000 respiratory illnesses in children every year.

The health benefits of the rule can actually be quantified and have been quantified to between \$6.7 billion and \$19 billion in value to the American public every year. This is a particularly important public health victory in States like Rhode Island, where more than 1 in 10 of our citizens suffer from asthma. There may be people here who don't care about that, but I do, and I think it is important that the public health side of the equation be recognized, as well.

I also applaud your efforts to regulate the carbon emissions that are coming from, first, to be new power plants and then, shortly, the regulations we hope for on existing power plants. We hope that we can do some work on your funding. It is unfortunate that, because of cuts, funding for Clean Water and Drinking Water State revolving funds had to be reduced by 30 percent and 17 percent, respectively. Those are important programs for our home States.

It is also unfortunate that lack of resources has required EPA to delay some of its work, at least in part due to the lack of resources. The coal ash standard that the Obama administration committed to in 2008 was the result of a dam collapse in Tennessee and a coal ash spill 100 times the size of the *Exxon Valdez* oil spill. In the last few weeks, tens of thousands of tons of coal ash from Duke Energy facilities contaminated 70 miles of river in North Carolina and Virginia.

Now, EPA has finally published the proposed rules in June 2010. There has not been action since. The Federal Court has finally instructed EPA to complete the rule this year. I hope the recent episodes with coal ash disaster have motivated you despite the cuts. But that is the price of putting EPA under the kind of financial pressure. When you want people not to do more with less, but to do less with less, then that is what you get, and I think it is very unfortunate for North Carolina and Virginia.

So I look forward to working with you. We actually, at last, have a budget timeframe that will allow appropriators to work through budgets and get into some detail, rather than have mad dashes and brinkmanship at the end between the President and the Speaker, for instance, without Senators having an opportunity to participate. So I am looking forward to working on that process.

And please continue to go forward on climate change; it is way past denial, as the American Academy for the Advancement of Sciences recent report shows, as NASA scientists have repeatedly showed. I find it remarkable that people contend that NASA doesn't know what it is doing when they have an SUV-sized vehicle drive around on the surface of Mars right now. That is a pretty good sign that these people know their science.

So thank you for being here. You have fans and supporters, and we will have your back.

Senator BOXER. Senator, thank you for staying so well within your time. The reason I am going to do a tough gavel is we have votes. If we can get down to the floor about 11:20, I think we will just make it.

So we will now turn to Senator Crapo, followed by Senator Inhofe.

**OPENING STATEMENT OF HON. MIKE CRAPO,
U.S. SENATOR FROM THE STATE OF IDAHO**

Senator CRAPO. Thank you, Madam Chairman, for holding this important hearing on the EPA's fiscal year 2015 budget proposal.

And thank you, Administrator McCarthy, for joining us today.

To begin with, I would like to echo my colleague's concerns regarding John Beale and his deep connections to regulatory decisions affecting all Americans. It seems difficult to conclude that any of Mr. Beale's work on the many initiatives under his purview at EPA can be trusted at face value. As such, I would like to take this opportunity to urge for a robust review of all rulemakings and regulatory actions connected with Mr. Beale's service at the EPA.

Moving to the budget in particular, the Federal Government continues to face severe budget challenges, and further attention is needed by Congress in order to improve our long-term fiscal outlook, knowing the funding priorities of executive branch agency is an important resource as Congress prepares its own budget and fiscal measures. I understand that the EPA, like all Federal agencies, has been working to do its part in achieving deficit reduction. However, I am perplexed by some of what I see in the EPA's budget proposals.

In reviewing the EPA's budget proposal, I am concerned that the Agency has proposed funding reductions for programs that enjoy strong bipartisan support and are critical programs, while increasing funding for programs on initiatives that remain controversial. Specifically, at a time when we have just heard about a new proposal for what I consider to be nothing more than a jurisdictional power grab over water with regard to our Clean Water Act and safe drinking water statutes, we also see in the budget proposal the proposed reduction of funding for the Clean Water and Safe Drinking Water State revolving loan funds. That is a big concern to me.

I think we all in America know that we are facing over \$200 billion of infrastructure needs in these arenas, and we have been working for years to try to get adequate budgets to help our Nation deal with its aging water infrastructure. And to see over \$580 million in reduction of that budget, when other parts of the EPA budget could have been looked to for the necessary savings, is disturbing. The small communities who need this assistance to ensure

that their water systems meet State and Federal environmental regulations are going to be badly harmed by this budget decision.

Additionally, the proposed reduction in funding for the brownfields program is discouraging. Just last summer I co-chaired an EPW subcommittee hearing in which we heard about the positive impact this program has had in Idaho and across the Nation.

Also, many of my colleagues and I continue to have serious concerns with the President's climate action plan and the use of Executive authority to circumvent Congress. The EPA's 2015 budget proposal clearly advocates the continuation of this alarming process.

There are many other things I could say, but in terms of trying to pay attention to the chairman's admonition to keep it brief, I will end with this. But, Administrator McCarthy, I encourage you to help find a way to correct the budget decisions that will short-fund our State revolving funds and to help us move forward in correcting that trend and, in fact, help us to get increased resources into this critical part of our Nation's water infrastructure. Thank you.

Senator BOXER. Senator, thank you so much.

Senator Booker.

**OPENING STATEMENT OF HON. CORY A. BOOKER,
U.S. SENATOR FROM THE STATE OF NEW JERSEY**

Senator BOOKER. Thank you very much, Chairwoman, for this opportunity. I want to thank not only the Chairwoman, but Ranking Member Vitter for holding this hearing.

Administrator McCarthy, I just want to welcome you. I am very excited about your leadership and the opportunity as a new Senator to serve with you because, for me, it is very obvious that the EPA's mission to protect public health is severely urgent. In the State of New Jersey, we have more Superfund sites than any other State. It is appalling how we, in the past, have not stepped up to hold people accountable for the messes that they are making, and we are spending billions of dollars of taxpayer money, I believe unnecessarily, in costs that should have been internalized by industry.

So I believe right now it is appropriate and important that the proposed EPA budget for 2015 needs to make addressing climate change as one of the Agency's top objectives. We must address the threats posed by climate change before it is too late and that we are cleaning up the more expensive damage that it will do in the future.

I am pleased to see in your budget proposed requests to allocate increased resources to climate change and air quality work, and to see funding specifically dedicated—and this gets me very excited—for preparing for the impacts of climate change. That includes technical assistance for adaptation, planning for risks associated with storm surges, a threat that we are very familiar with in New Jersey.

New Jersey is particularly vulnerable to the impacts of climate change. Scientists at Rutgers recently estimated that the New Jersey shore will likely experience a sea level rise of 1.5 feet by 2050 and 3.5 feet by 2100. The projections for the New Jersey coasts are

higher than the projections for average sea level rise globally. The projected sea level rise of 1.5 feet for 2050 for the New Jersey coast would mean places like Atlantic City, if there was a 10-year storm surge—not a 50-year storm or 100-year storm, but just the scale of storm that, on average, we see every 10 years—flood levels from that storm would be worse than any flooding that has ever been experienced in Atlantic City, and it would be far more routine.

EPA's budget justification also demonstrates the Agency's continued commitment to addressing issues of environmental justice, an area I would like to work closely with you on as we move forward. Climate change does not impact everyone equally. Low income and minority communities will be disproportionately impacted by future extreme weather events. While natural disasters may seem like equal opportunity destroyers, they are not. In today's economy, many people live in vulnerable communities and are one paycheck away from the devastating impact of poverty. In cities such as Newark and New Orleans, as we saw from Hurricanes Sandy and Katrina, one major storm can destroy fragile networks supporting families' access to food, shelter, and medicine. We must be prepared for increasing climate change.

Low income and minority communities are systematically more likely to lack parks and trees and green spaces, and have a higher concentration of pavement than wealthier communities. Newark, for example, where I was mayor, approximately 70 percent of its surface is impervious and only has 15 percent canopy coverage. The temperature of a paved surface absorbing summer heat can be 50 to 90 degrees above the temperature of a green surface. This leads to significantly higher air temperatures, which then result in increased air pollution, spikes in asthma rates, and more cases of heat stroke and even death among the elderly.

The EPA has taken important first steps toward reductions of carbon emissions by setting standards that will cut carbon pollution from automobiles and trucks nearly in half by 2025, but we know that the power plants make up at least a third of the Nation's CO₂ emissions; and I commend the Administration's work to limit greenhouse gas emissions from both new and existing power plants. The EPA has both the authority and the responsibility under the Clean Air Act to reduce pollution from these plants.

Administrator McCarthy, I look forward to working with you on these issues. I admire your courage in this overly partisan debate. The truth is we share one common destiny in this country. Whether you are a red State or blue State, Republican or Democrat, the threats to our climate are real and they are obvious, and we can do things to address them that actually increase economic opportunity for our Nation and uplift our higher aspirations to make this a country with liberty and justice for all, and for that I thank you for stepping forward to lead and I look forward, again, to working with you.

Senator BOXER. Thank you very much, Senator.
Senator Inhofe.

**OPENING STATEMENT OF HON. JAMES M. INHOFE,
U.S. SENATOR FROM THE STATE OF OKLAHOMA**

Senator INHOFE. Thank you, Madam Chairman.

Ms. McCarthy, even though we have a good personal relationship, I am growing increasingly concerned about the EPA's systematic distortion of the costs and benefits. We hear a lot about the benefits, but not the costs. While it is quick to turn over every stone to find every conceivable benefit that could come from a new rulemaking, the Agency exerts just as much effort to cut corners and ignore the reality so it can downplay the true economic costs of these regulations. This distortion enables the Agency to enact outlandish rules of obscene costs and harm to the economy and the American public without any respect to the cost-benefit balance enshrined in the foundation of our environmental laws.

This topic has been one of focus to the committee, as evidenced by the recent report. We have already talked about John Beale and I won't elaborate on that, but more damage than the money he stole from the taxpayers is that he and others wrote the playbook on how to get away with this distortion of costs and benefit. For the sake of the American public, it is time to aggressively rein in this practice.

As one example, let me just consider utility MACT rule. The utility MACT is the rule that requires powerplants to reduce certain components of their missions. The Clean Air Act requires these rules to be updated periodically, but only as technology allows and to the extent that the benefits outweigh the rule's full cost to the economy. In its cost estimate, the EPA stated the rule would create 46,000 temporary construction jobs and 8,000 net permanent jobs.

Now that this rule has set in, we are starting to see its real impact, and the facts reveal that the rule has not only had a devastating impact on coal production across the country, but it also resulted in dozens of power plants being shut down, which has caused significant increases in electricity prices around the country.

The New York Times reported on these impacts on March 10th. They wrote, "Underlying the growing concern among the consumers and regulators is a second phenomenon that could lead to even bigger price increases: scores of old coal-fired power plants in the Midwest will close in the next year or so because of Federal pollution rules. Still others could close because of a separate rule," we are talking about the water rule, "for utilities. Another frigid winter like this could lead to a squeeze in supply, making it even harder and much more expensive to supply power." That is all a quote from the New York Times.

But this is already happening. The article reported that in Rhode Island a utility received permission to raise prices 12 percent over the previous years. In Pennsylvania, utility bills have tripled in some places. What is shocking to me is the New York Times is connecting these increases back to the EPA's regulation. So I have to wonder is it even remotely possible that the utility MACT rule created 8,000 net permanent jobs as EPA said it would. If this is causing electricity prices to triple in some areas, how is that possible?

Before I came to Congress, I was in business, and when input costs go up, it doesn't create jobs; it lowers profits, it puts strains on the margins of the business. The same is true with the whole economy. And when an input cost as significant as electricity begins to soar in cost or wobble in reliability, the impact is negative

and felt across the entire economy; it destroys jobs, it doesn't create 8,000 new jobs. That the Obama EPA can get away with this kind of distortion proves the Agency, in my opinion, is out of control, and this is something I am going to focus on for the rest of the year; it is simply too important for us not to. EPA's impact may be coal now, but we know it is going to be natural gas next. Whether it is hydraulic fracturing or methane emissions, the EPA is intent to carry out what the Sierra Club has named its Beyond Natural Gas campaign, just as the EPA did with Sierra Club's Beyond Coal campaign.

We in the Senate are charged with stewarding this Nation, which includes watching out for those who are most vulnerable. The elderly and the poor are most at risk for losing their homes and health due to the skyrocketing electricity bills, which is exactly what will happen under the EPA's war on fossil fuels. It is our job to watch out for them. These are the most vulnerable people, I suggest to my good friend from New Jersey.

So I would only say, Madam Chairman, I am going to have to excuse myself for a while for an Armed Services obligation, but I am going to be coming right back.

Senator BOXER. Sure.

Senator INHOFE. And hopefully we will have a chance to respond to some of these comments made concerning climate change.

Senator BOXER. Thank you. I am excited what you said about the elderly and the poor, so we will work together on that.

Let me say what I am going to do, unless there is objection. We are going to hear from the two Senators who haven't been heard from, and then I am going to shut down the comments here so that we can get to Gina McCarthy. Colleagues coming in can do their opening statement with their questions. Is that OK with everyone? OK, that is excellent.

So we will hear from Senator Wicker, followed by Senator Sessions.

**OPENING STATEMENT OF HON. ROGER WICKER,
U.S. SENATOR FROM THE STATE OF MISSISSIPPI**

Senator WICKER. I think that is a very good solution, Madam Chair.

Senator BOXER. All right.

Senator WICKER. I would like to ask unanimous consent to place in the record at this point an op ed from WallStreetJournal.com entitled How Carbon Dioxide Became a "Pollutant."

Senator BOXER. Without objection.

[The referenced document follows:]

How Carbon Dioxide Became a 'Pollutant'

Wall Street Journal

By KEITH JOHNSON
Updated April 18, 2009 12:01 a.m. ET

The Environmental Protection Agency's decision to classify rising carbon-dioxide emissions as a hazard to human health is the latest twist in a debate that has raged for decades among politicians, scientists and industry: whether a natural component of the earth's atmosphere should be considered a pollutant.

The EPA's finding doesn't say carbon dioxide, or CO₂, is by itself a pollutant -- it is, after all, a gas that humans exhale and plants inhale. Rather, it is the increasing concentrations of the gas that concern the agency.

Carbon-dioxide levels in the Earth's atmosphere have fluctuated wildly for millennia; at one point billions of years ago, it was the dominant gas in the atmosphere.

However, the EPA ruled that today's higher concentrations are the "unambiguous result of human emissions." Concentrations of carbon dioxide and other gases "are well above the natural range of atmospheric concentrations compared to the last 650,000 years," the agency said.

Over the years, many pro-business groups have discouraged regulation of carbon-dioxide emissions by arguing that CO₂ is an essential ingredient of life. In its decision, the EPA stressed that it considers CO₂ and other so-called greenhouse gases to be pollutants because of their role in propagating climate change, not because of any direct health effects.

In 1998, the Clinton administration EPA studied the question and determined that the Clean Air Act was "potentially applicable" to CO₂ and other greenhouse gases. But despite continued pressure from environmental groups, the administration never moved to regulate the gases.

According to the bulk of scientific research, such as that assembled by the Intergovernmental Panel on Climate Change, the more greenhouse gases there are in the atmosphere, especially carbon dioxide, the more heat is trapped. That leads to rising temperatures. The EPA endorsed the IPCC research and specifically said that "natural variations" in climate, such as solar activity, couldn't explain rising temperatures.

The EPA lumped carbon dioxide with five other gases -- methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride -- into a single class for regulatory purposes. That's because they share similar properties: All are long-lived and well-mixed in the atmosphere; all trap heat that otherwise would leave the earth and go into outer space; and all are "directly emitted as greenhouse gases" rather than forming later in the atmosphere.

Alternatively, tropospheric ozone wasn't included in the class, even though it creates smog and contributes to global warming. But that gas isn't emitted directly; rather, it is created in the atmosphere when sunlight reacts with greenhouse gases emitted by human activity such as engine combustion and industrial processes.

Similarly, the EPA declined to consider regulating water vapor or soot, also known as "black carbon," both of which are big contributors to the greenhouse effect but which don't share common properties with the six greenhouse gases.

The EPA did acknowledge some positive impacts from higher CO₂ concentrations. One is faster-growing trees in tropical forests, which helps offset deforestation. Another is marshes that can more quickly grow above rising sea levels, providing an insurance policy of sorts for some low-lying areas against the potential ravages of rising sea levels resulting from warmer global temperatures.

The EPA also acknowledged some positive aspects of rising temperatures, but concluded that on balance, the negative impacts of climate change outweigh the positive.

Senator WICKER. Thank you. And I do it for this purpose, Madam Chair and Administrator McCarthy: We have had a lot of discussion already this morning in the form of opening statements about the proven dreaded results of particulate pollution and poisons put into our environment, an issue where everyone in this room agrees. We have heard discussion in statements about respiratory illnesses; we have heard endorsements by the American Lung Association; we have talked about asthma; particulate pollution in China, this awful picture that the chairman showed showing smog in China; discussions of coal ash; Superfund sites.

And then without making any distinction at all between these poisons and particulate pollutants, my friends on the other side of the dais switch almost in the same sentence to climate change, where the target there is greenhouse gases and carbon dioxide, making no distinction between the fact and making no mention of the fact that CO₂ and greenhouse gases have nothing to do with respiratory illnesses or with lung disease or asthma or smog in China or coal ash or Superfund sites, something we all are very much interested in.

And I would point out to my colleagues that toward the end of this op ed that is now part of the record, EPA acknowledged some positive impacts from higher CO₂ concentrations. One is faster growing trees in tropical forests, which helps offset deforestation. EPA has acknowledged that. CO₂ is good for the rainforest. Another is that marshes can grow more quickly above rising sea levels, providing an insurance policy of sorts for low-lying areas against the potential ravages of rising sea levels.

So, at any rate, I would just point out that there are differences on this committee about the effect of CO₂ on climate change, but no one is suggesting that CO₂ causes lung disease, asthma, or the kind of smog that the chairman talked about.

I will tell you what we do agree on, Administrator McCarthy. We agree that there are some mighty fine programs that the Administration is proposing cuts for. The 2015 budget process, the budget of the Administration proposes cutting \$430 million from the Clean Water Revolving Loan Fund, \$150 million from the Drinking Water Revolving Fund, and \$5 million from the Brownfields Program. This is something we can all agree on: these are proven programs that are well received by State and local communities, encourage the EPA to work with communities in a cooperative manner rather than a confrontational one.

These cuts are even more troubling considering that some estimate the amount needed to bring local water infrastructure into EPA regulations is over \$2.5 trillion. We need to be helping local communities rather than putting unfunded mandates on them.

All across the Federal Government, agencies are having to make tough decisions to rein in the country's spending. I would rather we help communities with safe drinking water and with safe air, rather than putting some funding of dubious value into CO₂ regulation in the name of climate change.

I am also concerned that EPA addresses out-of-compliance communities often with subpoenas and civil action, when we should be coming to them with technical assistance and grants. EPA's enforcement actions may help achieve compliance, but when small

and rural communities must funnel meager funds away from schools and hospitals, I question the efficacy of this approach.

I raised many of these same issues in the record during Administrator McCarthy's nomination hearing. I look forward to visiting with her about these in the future.

Finally, I hope we can work together to strengthen the partnership between EPA and small rural communities in developing and complying with regulations to protect our environment and our citizens. This is an issue upon which Republicans and Democrats can agree.

Senator BOXER. Senator, thank you.

Finally, Senator Sessions.

**OPENING STATEMENT OF HON. JEFF SESSIONS,
U.S. SENATOR FROM THE STATE OF ALABAMA**

Senator SESSIONS. Thank you.

Senator Wicker, I thank you for saying what you said, it was very important. CO₂ is an odorless, tasteless gas we emit when we breathe, and plants all breathe it in and grow faster when there is more CO₂, a fact which cannot be denied. We need to differentiate that between the kinds of actual pollutants that make people sick, and we can do that. We have made a lot of progress in America to clean up the air, and we need to keep at it, but we need to be smart about it. It is a bit disingenuous when I hear people say carbon, carbon, carbon, and what they really mean is CO₂. They use the word carbon and it makes people think of soot and particulates and things of that nature, and I think that really misrepresents the issue somewhat.

Ms. McCarthy, I am concerned about spending. We are going to see interest on our debt grow from \$211 billion last year, according to the Congressional Budget Office, to \$880 billion in 1 year 10 years from now. Every agency has to watch its spending, and Congress has a clear duty to monitor spending.

The ozone standard that you sought or your department sought to advance early is an example, I believe, of wasted money. In 2008, after a process that took 8 years, EPA tightened significantly the ozone standard. That was done in a proper way. And under the Clean Air Act the ozone standard was to be reviewed again in 5 years. Yet almost immediately upon coming into office, the Obama EPA began a costly and premature process of reconsidering the ozone standard to make it even more stringent, and this reconsideration was recognized as one of the most expensive environmental regulations ever proposed, with some estimates reaching \$90 billion in annual costs. I objected to that; 30 Senators wrote to object to that, and that decision was reversed. I simply asked how much did this cost in the 2 years that it was undertaken before it was abandoned; how much money was wasted; how much money was spent on that, and I have inquired on several different occasions.

I would offer for the record a letter that I wrote on a letter that you wrote to me, a letter that was written by the Republican members of this committee to you asking about an analysis of what you spent, and, in effect, you responded this way, or at least your Assistant Administrator Janet McCabe: "It is difficult for EPA to estimate with any meaningful precision the expenses and full-time

equivalent employees used for the reconsideration of the 2008 ozone standard specifically.”

Well, it is not difficult for you to answer that question. I think that is a direct refusal to answer. And you said at the hearing, when I asked you about it, that you would do that. I asked you to provide a response, if you would respond to the question for the record, and you answered, I absolutely will. You were specifically asked, did EPA incur significant costs as part of the ozone reconsideration? If so, how much? And you ignored that question.

Can you not provide us the information that we asked? That will be a question I will be asking you. I think it is a responsible action for us to ask about and we will continue to press it.

Madam Chairman, I will wrap up. Thank you for the opportunity to ask these questions. And I will share Roger Wicker, Senator Wicker’s concern that we are moving money from State programs for clean water and water treatment to the bureaucracy at EPA. I think that is the wrong path to take.

[The referenced letters follow:]

United States Senate
WASHINGTON, DC 20510

December 17, 2013

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington DC 20460

Re: Taxpayer Funds Expended on Reconsideration of Ozone NAAQS

Dear Administrator McCarthy:

We are writing to renew a longstanding, unanswered request for data related to federal funds and resources expended as part of EPA's unnecessary reconsideration of the national ambient air quality standard (NAAQS) for ground level ozone in the 2010-2011 timeframe. As you know, ozone attainment status significantly impacts state and local transportation planning, energy production and use, and economic development. EPA's reconsideration of the ozone standard in 2010-2011, years ahead of the regularly-scheduled review process established in the Clean Air Act (CAA), caused economic and regulatory uncertainty throughout the United States. Private businesses and organizations as well as federal, state, and local agencies incurred significant expenses analyzing EPA's proposal as well as participating in the public comment process. As the Assistant Administrator with responsibility for EPA's Office of Air & Radiation at the time, you led this ozone reconsideration effort and, as the Administrator, you are responsible for overseeing the current ozone review.

Many recognized EPA's reconsideration initiative as lengthy and unnecessary. For example, a recent report by the Congressional Research Service (CRS) suggests that the reconsideration was done as a political, rather than legal, matter and notes that the process took over a year and a half. Specifically, CRS explains:

*With the change of Administrations in 2009, EPA agreed to reconsider the 2008 [ozone] standard. As a result, a more stringent primary standard and a different version of the secondary standard were proposed in January 2010. After a year and a half of public comment and review, EPA sent what it considered a final set of standards to OMB for interagency review. The process was short-circuited, however, by a Presidential decision to await conclusion of the next regular review—the review now nearing completion—before promulgating any change.*¹

¹ CRS Report, Ozone Air Quality Standards: EPA's 2013 Revision (May 30, 2013) (emphasis added).

Moreover, as outlined in the recent Senate Environment and Public Works (EPW) Committee Minority Report entitled “Neglecting a Cornerstone Principle of the Clean Air Act: President Obama’s EPA Leaves States Behind,”² many states commented about the adverse impacts of the ozone reconsideration proposal. For instance, the Ohio Environmental Protection Agency commented:

*The timing of the proposal, i.e., reopening the standard just two years after it was set, is ill-considered and inconsistent with the schedule for review of NAAQS contained in the Clean Air Act... Attempting to implement a new standard while the previous standard is still being implemented has consistently caused strain, redundancy and inefficiency in the process and has led to seemingly endless rounds of litigation that takes the focus away from the important task at hand--real air quality improvements... U.S. EPA...should not add to the uncertainty and strain generated by the existing Clean Air Act obligations for attaining the ozone standard and generated by the five-year review of that NAAQS by prematurely reevaluating and reestablishing the ozone standard when neither law nor science requires it.*³

Similarly, the Missouri Department of Natural Resources commented:

*[I]t cannot be overemphasized how much of an impact the reconsidered standard will have on limited resources at the state level... [T]he statewide public outreach effort required to provide information and notice to all affected areas will be unprecedented.*⁴

Other states commented as well, as discussed in the aforementioned EPW minority report. Additionally, a bipartisan coalition of concerned members of Congress urged EPA to forego the unnecessary reconsideration process.⁵

² Senate Environment and Public Works Committee Minority Report, “Neglecting a Cornerstone Principle of the Clean Air Act: President Obama’s EPA Leaves States Behind” (October 31, 2013).

³ Comments of Ohio Env’t. Prot. Agency on EPA’s Proposed 2010 Ozone Standards, Docket ID No. EPA-HQ-OAR-2005-0172-12376, at 3-4 (March 22, 2010).

⁴ Comments of Mo. Dep’t of Natural Res. on EPA’s Proposed 2010 Ozone Standards, Docket ID No. EPA-HQ-OAR-2005-0172-12905, at 1-3 (March 16, 2010).

⁵ Senate Environment and Public Works Committee Press Release, “Sessions Leads Bipartisan Effort Asking EPA To Not Change Its Air Quality Standard” (July 26, 2011); see also Letter from Sens. Voinovich, Bayh, Lugar, Landrieu, Vitter, McCaskill, and Bond to EPA (Aug. 6, 2010), available at <http://www.insideindianabusiness.com/newsitem.asp?ID=43052>.

Finally, even the President of the United States stepped in and recognized that this effort had to stop. In August 2011, when President Obama directed EPA to not proceed with the ozone reconsideration process, he explained that he “did not support asking state and local governments to begin implementing a new standard that will soon be reconsidered.” In other words, following 18 months of an unnecessary federal regulatory process that was not mandated by the CAA, the President ordered EPA to stand-down.⁶

Soon after the President’s decision, Senator Sessions wrote EPA in September 2011 inquiring about the “total costs incurred or expended by [EPA] ... on efforts related to reconsideration of the 2008 [ozone standard].” However, ever since that request, EPA has evaded providing a response. At your confirmation hearing, in April of this year, Senator Sessions asked you if you would respond to his questions for the record. You responded: “I absolutely will.”⁷ In those questions, you were specifically asked: “Did EPA incur significant costs as part of the ozone reconsideration process; if so, how much?” You wholly ignored the question in your response to the Committee, violating your pledge before the Committee. Again, in May of this year, EPA staff wrote Senate staff: “We haven’t tracked down a response but are working on it.” To date, no official EPA response has been provided. It has now been 26 months since the initial request.

We can only conclude, in the face of repeated refusals to respond to or acknowledge a legitimate question about how taxpayer money has been spent by EPA, that EPA either seeks to thwart our oversight role in this matter or cannot answer the question. Either explanation is deeply troubling. As Members of the Senate Committee with direct jurisdiction over EPA and the CAA, we have a responsibility to oversee Agency actions, including how it expends the resources made available to it by Congress. Our request is neither overly complex nor burdensome.

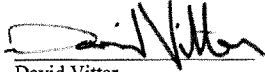
Again, we request that EPA provide to the Committee an accounting of EPA expenses incurred as part of its abandoned 2010-2011 ozone NAAQS reconsideration including the total costs incurred or expended by EPA from January 21, 2009 through August 31, 2011 on efforts related to the Agency’s reconsideration of the 2008 NAAQS for ground level ozone. The estimate should account for EPA staff time (including salaries and benefits); expenses associated with the public hearings in Arlington, Virginia; Houston, Texas; Sacramento, California; as well as any other public hearings or meetings; third-party expenses for consultants, scientists, or other persons; and any other expense incurred by the Agency as part of this effort. In addition to the monetary costs of these efforts, please also provide the total man-hours expended by EPA staff on this effort during the stated timeframe.

⁶ Office of Information and Regulatory Affairs, Letter from Cass Sunstein to Lisa Jackson (September 2, 2011).

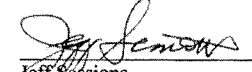
⁷ Senate Environment and Public Works Hearing, “Hearing on the Nomination of Gina McCarthy to be Administrator of the U.S. Environmental Protection Agency” (April 11, 2013).

We look forward to your prompt and thorough response by January 7, 2014.

Sincerely,



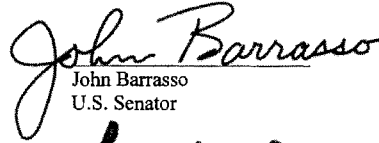
David Vitter
U.S. Senator



Jeff Sessions
U.S. Senator



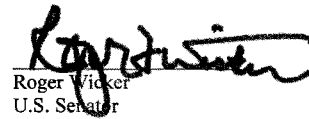
James Inhofe
U.S. Senator



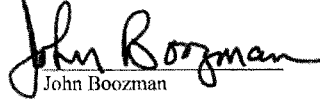
John Barrasso
U.S. Senator



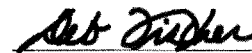
Mike Crapo
U.S. Senator



Roger Wicker
U.S. Senator



John Boozman
U.S. Senator



Deb Fischer
U.S. Senator



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 15 2014

OFFICE OF
AIR AND RADIATION

The Honorable Jeff Sessions
United States Senate
Washington, D.C. 20510

Dear Senator Sessions:

Thank you for your December 17, 2013, letter regarding the total costs incurred by the U.S. Environmental Protection Agency on efforts related to the reconsideration of the 2008 National Ambient Air Quality Standard (NAAQS) for ozone. The Office of Air and Radiation had primary responsibility for the ozone reconsideration, with staff from the Office of Research and Development and the Office of General Counsel also playing a role.

As you know, section 109(d) of the Clean Air Act requires the EPA to complete a review of the science upon which the NAAQS are based every five years. The standards for the six principal pollutants – carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, particulates, and ozone – are reviewed and revised on a rotating basis. EPA staff members who worked on the reconsideration of the 2008 standard are dedicated to understanding the science of public health problems from air pollution and advising the Administrator on how to set the standards. At any given time EPA staff may be working on some aspect of one or more of the NAAQS standards. The staff continually reviews health and environmental impacts of the pollutants identified in the Clean Air Act as NAAQS pollutants. During the reconsideration of the 2008 standard, the EPA also held public hearings with a wide variety of stakeholders in attendance.

The EPA is always learning more about how to set air pollution standards. The agency is using some of the work from the reconsideration effort to help inform NAAQS decisions moving forward. The agency is working on the next regular review of the ozone standard to determine what, if any, revisions to the ozone standards may be appropriate in light of the current scientific evidence. For these reasons, it is difficult for us to estimate, with any meaningful precision, the expenses and full-time equivalent employees used for the reconsideration of the 2008 standard specifically.

Again, thank you for your letter. If you have further questions, please contact me or your staff may contact Josh Lewis in the EPA's Office of Congressional and Intergovernmental Relations at lewis.josh@epa.gov or (202) 564-2095.

Sincerely,

A handwritten signature in black ink, appearing to read "J. G. McCabe".

Janet G. McCabe
Acting Assistant Administrator

Senator BOXER. Senator, thank you so much for keeping it under the time limit.

Yes, Administrator McCarthy, this is your time. Welcome.

**STATEMENT OF HON. GINA McCARTHY, ADMINISTRATOR, U.S.
ENVIRONMENTAL PROTECTION AGENCY**

Ms. McCARTHY. Thank you. Chairman Boxer, Ranking Member Vitter, and members of the committee, thank you for the opportunity to discuss the Environmental Protection Agency's proposed fiscal year 2015 budget. I am joined by the Agency's Acting Chief Financial Officer, Maryann Froehlich.

EPA's budget request is \$7.980 billion for the 2015 fiscal year starting October 1, 2014. This budget meets the challenges of domestic spending constraints while still fulfilling our mission to protect public health and the environment.

The fiscal year 2015 budget reflects EPA's plans to take advantage of new technologies and new regulatory and non-regulatory approaches; it recognizes that EPA is part of a larger network of environmental partners and States, tribes, and communities.

This budget will provide the support for a smaller work force by focusing on real progress in priority areas in communities about climate change and air quality, toxics and chemical safety, as well as clean water.

And we are asking for \$7.5 million and 64 staff in fiscal year 2015 to help provide green infrastructure technical assistance for up to 100 communities to provide cost-effective approaches for water management.

In addition, the budget requests continues our environmental justice efforts. We will do more to partner with States, tribes, and local governments and other Federal agencies. Funding for State and tribal assistance grants, or STAG, dollars is once again the largest percentage of EPA's budget.

Addressing the threat from a changing climate is one of the greatest challenges of this and future generations. The request designates \$199.5 million specifically for this work.

The Agency has added \$10 million in 24 FTEs in fiscal year 2015 to support the President's Climate Action Plan, with \$2 million designated for adaptation planning.

The Agency will also focus resources on the development of common sense and achievable greenhouse gas standards for power plants, the single largest source of carbon pollution. When it comes to cutting greenhouse gas emissions, the President's budget provides support for the States to help them implement the Clean Air Act.

The EPA budget requests almost \$673 million to support work to improve chemical safety for all Americans, and especially our children.

We are requesting \$23 million and 24 FTEs in 2015 to support activities under the President's Executive Order on chemical safety, as well as Agency efforts on chemical prioritization, air toxics, radon, and volatile organic compounds in drinking water.

The Nation's water resources are the lifeblood of our communities. We are requesting \$1.775 billion for the Clean Water and Drinking Water State Revolving Funds.

The Agency is also directing \$8 million and 10 FTEs to advance clean water infrastructure and sustainable design like the Municipal Separate Storm Sewer Systems Program for technical support to communities.

E-Enterprise is a major joint initiative between EPA and the States to modernize our business practices, to get us into the 21st century, to develop a new business model that looks toward the future. The benefits of implementing the E-Enterprise initiative can be seen in the budget. Just the E-Enterprise initiative of E-Manifest alone includes annual savings estimated at \$75 million for over 160,000 waste handlers.

In fiscal year 2015, the Agency is requesting \$1.33 billion to continue to apply effective approaches for clean up of RCRA, Superfund, Leaking Underground Storage Tank, and other authorities. This strategy will ensure land is returned to beneficial use. \$1.16 billion is requested for Superfund, which includes a \$43.4 million increase for remedial work and an increase of \$9.2 million for emergency response and removal.

The fiscal year 2015 budget includes a total of \$1.13 billion in categorical grants. Within that total is over \$96 million for tribal general assistance program grants, an \$18 million increase for pollution control, a \$16 million increase for environmental information grants, and a \$15 million increase for State and local air quality management.

Science is at the foundation of our work at EPA, and science is supported by the President's budget request of \$537.3 million.

Last, across the Administration we recognize the importance of the 2-year budget agreement Congress reached in December, but the resulting funding levels are not sufficient to expand opportunities to all Americans or to really drive the growth of our economy in the way that is needed.

For that reason, across the Federal Government, the budget also includes a separate, fully paid \$56 billion initiative that is supporting climate resilience. EPA would be the beneficiary of approximately \$15 million.

Chairman Boxer, I thank you for the opportunity to testify, and I will take your questions.

[The prepared statement of Ms. McCarthy follows:]

**TESTIMONY OF
GINA McCARTHY**

**ADMINISTRATOR
U.S. ENVIRONMENTAL PROTECTION AGENCY**

BEFORE THE SENATE ENVIRONMENT AND PUBLIC WORKS COMMITTEE

WEDNESDAY, MARCH 26, 2014

Chairman Boxer, Ranking Member Vitter, and members of the Committee, thank you for the opportunity to appear before you to discuss the Environmental Protection Agency's proposed FY 2015 budget. I'm joined by the Agency's Acting Chief Financial Officer, Maryann Froehlich.

EPA's budget request of \$7.890 billion for the 2015 fiscal year starting October 1, 2014 reflects our ongoing efforts to meet the challenges facing the agency today and into the future. Despite these challenges, we remain dedicated to protecting public health and the environment, and we know we must target staff and resources and find new ways to fulfill our mission. We will focus those resources in a way that will allow EPA to be more effective and efficient.

The FY 2015 budget reflects a strategic approach to our budget planning process, looking toward the future rather than continuing to simply react to tough budget choices with cuts across the Agency. The FY 2015 budget request does this in the following ways:

- It reflects EPA's incorporation of new technologies and new regulatory and non-regulatory approaches that can help us maintain our efficiency and effectiveness.
- It strengthens EPA's partnership with public health and environmental protection partners in states, tribes and local communities with a focus on aligning our resources, avoiding duplication, and identifying and closing any gaps in the broader environmental enterprise system.
- It invests our funds and leverages funds of our partners where it makes the most sense and gets the biggest bang for the buck.

Following the framework of priorities laid out in the FY 2014 - 2018 Strategic Plan and working within our budget, we are committed to ensuring the staff we have in program areas and regions make the most sense and will have the most impact.

EPA has already taken steps toward proactive management of our operating budget. Through the VERA/VSIP process, we have begun to accelerate attrition within EPA both at headquarters and the regions toward a ceiling of 15,000 nonrefundable FTE's.

Our FY 2015 budget relies on a reduced workforce focused on programs, policies, and regulations that matter most to public health and the environment. This is not simply about cutting the workforce to save costs. We are reshaping the workforce and our work to meet current and future challenges. Doing this includes making key investments.

It makes long-term fiscal sense to invest the cost savings achieved -- through a smaller workforce and improved use of technology -- to work smarter and more effectively. This approach will keep EPA strong, focused on science and the law, and transparent in addressing environmental challenges and the results we have achieved.

This budget will provide the support we need to move forward by targeting real progress in priority areas: communities, climate change and air quality, toxics and chemical safety, and clean water.

Building on current work on the ground in our communities, we are asking for \$7.5 million and 64 staff in FY 2015 to work toward efforts that will make a difference in people's everyday lives and in their communities. Those efforts include providing green infrastructure technical assistance for up to 100 communities that will promote cost-effective approaches to water management.

This budget request furthers our environmental justice efforts. The protections provided by our national environmental laws must be accessible to everyone. We will do more to partner with states, tribes, and local governments and other federal agencies to better coordinate and leverage resources supporting community efforts.

Addressing the threat from a changing climate is one of the greatest challenges of this and future generations. The request for climate change and air quality is \$1.03 billion—over \$41 million more than fiscal year 2014. And it designates \$199.5 million specifically for climate change work.

Building on existing efforts and base budget resources, the Agency has added \$10 million and dedicates 24 FTE's in FY 2015 to support the President's climate action plan. \$2 million is designated for technical assistance for adaptation planning for water utilities at greatest risk from storm surges. Research and development efforts will focus on support tools for at-risk communities and tribes in preparing for the impacts of climate change.

The Agency will focus resources on the development of common sense and achievable greenhouse gas standards for power plants—the single largest source of carbon pollution. The President's budget provides support for the states to help them meet their obligations under Section 111 of the Clean Air Act with regard to cutting carbon emissions.

This request also supports the President's interagency methane strategy and the President's recently announced directive to EPA to develop phase 2 fuel efficiency and greenhouse gas standards for heavy-duty vehicles. EPA also will be implementing a range of activities in support of the President's call to cut energy waste in homes, businesses, and factories.

Chemicals and toxic substances are prevalent in our everyday lives. The EPA budget requests almost \$673 million to support work to reduce the risk and increase the safety of chemicals and prevent pollution for all Americans and especially children.

We are requesting \$23 million and 24 FTE in FY 2015 to support activities under the President's executive order on chemical safety, as well as Agency efforts on chemical prioritization, air toxics, radon, and volatile organic compounds in drinking water. \$5 million in resources for air toxics work will enhance our capabilities to design effective regulations and continue developing the national air toxics assessment.

The nation's water resources are the lifeblood of our communities. The FY 2015 budget recognizes the long-term benefits of healthy aquatic systems for all aspects of our daily lives.

The Agency is directing \$8 million and 10 FTE to advance clean water. Resources are also proposed for the municipal separate storm sewer systems program for technical support to communities that must develop effective stormwater permits for the first time.

We are requesting \$1.775 billion for the clean water and drinking water state revolving funds. Although this is a more than a \$580 million decrease over FY 2014 levels, federal capitalization of the SRFs totals over \$22 billion since FY 2009, if you include the FY 2015 request. The FY 2015 budget seeks to ensure that federal dollars provided through the fund lead to the design, construction, and support of sustainable water infrastructure.

The EPA is looking toward future ways to better serve the American people by employing technology where it can be used more effectively. E-Enterprise is a major joint initiative between EPA and states to modernize our business practices and to increase responsiveness. This effort holds the promise of increased effectiveness and savings for businesses as well as government. The agency is expanding efforts in the second year of the multi-year E-Enterprise business model including focusing people and resources to accelerate development of the E-Manifest system and associated rule-making work. For example, the benefits of implementing the E-Manifest system include annual savings estimated at \$75 million for over 160,000 waste handlers. Transitioning from a paper-based system saves time and effort for every person who used to handle that paper.

In addition, EPA is making changes to long-standing business practices such as contracts, grants management, and the regulation development process. One important area of emphasis is improving freedom of information act (FOIA) and records management.

In FY 2015, the Agency is requesting over \$1.33 billion to continue to apply the most effective response approaches for cleanups under RCRA, Superfund, Leaking Underground Storage Tank, and other authorities. This strategy will help ensure land is returned to beneficial use in the most effective way. \$1.16 billion is requested for Superfund which includes a \$43.4 million increase for remedial work and an increase of \$9.2 million for emergency response and removal.

In this budget, we hold firm our priority support for state and tribal partners, the primary implementers and front line of environmental programs. Funding for state and tribal assistance grants – or STAG – is once again the largest percentage of the EPA's budget request and prioritizes funding for state categorical grants.

The FY 2015 budget includes a total of \$1.13 billion in categorical grants – a net \$76 million increase over FY 2014.

- Within that total is over \$96 million for tribal general assistance program grants – a \$31 million increase over FY 2014.
- We also included an \$18 million increase for pollution control (Section 106),
- There is a \$16 million increase for environmental information grants.
- There is a \$15 million increase for state and local air quality management in our request.

Science is the foundation of our work at the EPA. And science is supported by the President's request of \$537.3 million. In FY 2015, the EPA is focusing research on the most critical issues facing the Agency.

These include efforts to: advance chemical prioritization and predictive toxicology, help communities make sustainable decisions regarding environmental protection and resilience, and inform regional and community level strategies for the use of green infrastructure and other innovative alternative practices.

The EPA continues to focus on reducing its physical footprint and achieving greater energy efficiency. Since 2006, the EPA has released approximately 428 thousand square feet of space nationwide, resulting in a cumulative annual rent avoidance of over \$14.6 million.

The EPA continues to eliminate programs that have served their purpose, accomplished their mission, or are duplicative. The FY 2015 budget eliminates a number of such programs totaling nearly \$56 million. These include beaches protection categorical grants, state indoor radon grants, and diesel emissions reductions assistance grants.

Recognizing the importance of the two-year budget agreement congress reached in December, which the President's budget adheres to, levels are not sufficient to expand opportunity to all Americans or to drive the growth our economy needs.

For that reason, across the federal government, the budget also includes a separate, fully paid for \$56 billion opportunity, growth, and security initiative. This initiative—split evenly between defense and non-defense funding—shows how additional discretionary investments in FY 2015 can spur economic progress, promote opportunity, and strengthen national security.

- Within the initiative is \$1 billion for a climate resilience fund, through which the budget will invest in research and unlock data to better understand and prepare for impacts of a changing climate. These investments will also fund breakthrough technologies and resilient infrastructure.
- Within the climate resilience fund, EPA will support a nation better prepared for the impacts of climate change—with \$10 million for protecting and enhancing coastal wetlands, and \$5 million to support urban forest enhancement and protection.

We have made some very difficult choices in this budget. But we need to look realistically at challenges we face in the future and make sure we have the best tools and people in the right places to make the most difference. Our final FY 2015 budget reflects a balanced approach to accomplishing this.

Thank you for the opportunity to touch upon some of the highlights of EPA's FY 2015 budget request in my testimony today. I look forward to answering your questions.

Questions Submitted for the Record by Senator Boxer

Question 1: Given the importance of limiting carbon pollution and addressing climate change, increasing EPA's FY2015 Budget to address climate change is critical. Can you please explain how increased funding for the Agency's climate change work will ensure that state governments can efficiently implement and comply with any planned or existing Clean Air Act standard that establishes limits on carbon pollution from stationary sources?

Answer: The EPA's FY 2015 requested increase reflects funding for states to lay the ground work to support the President's Climate Action Plan and, in particular, activities associated with developing state plans to implement the carbon pollution guidelines for existing power plants. While state plans to address greenhouse gas emissions from the power sector are not due before 2016, FY 2015 will be an important year for states to build capacity and prepare for state plan development.

Question 2: The EPA's FY 2015 Budget supports implementation of the President's Climate Action Plan by calling for limits under the Clean Air Act on carbon pollution from cars, trucks, and power plants. Are these agency actions consistent with the Supreme Court decision in *Massachusetts v. EPA* (2007) and more recent decisions from the U.S. Court of Appeals for the D.C. Circuit?

Answer: The EPA's actions are consistent with the 2007 Supreme Court and U.S. Court of Appeals for the D.C. Circuit decisions.

Question 3: EPA's revolving loan programs for drinking and wastewater infrastructure help to ensure that the water we drink is safe and that our lakes and rivers are clean. EPA's budget request cuts funds for these important programs. Can you please explain how EPA will ensure adequate investments in clean water and drinking water are being made?

Answer: The FY 2015 budget request balances environmental protection with fiscal realities. This request supports the continued work of the State Revolving Fund (SRFs) in ensuring that small and underserved communities have access to funding that helps address their water infrastructure needs. Over the course of the life of the SRFs, approximately \$130 billion in assistance has been provided to projects, from all sources, including federal, state match, net leveraged bond, repayment of loan principal, and others. Since FY 2009, over \$22 billion in federal capitalization funding has been provided to the SRFs.

Question 4: The EPA has reported on the impressive and immediate health and environmental benefits of the National Diesel Emission Reduction Act Program, including significant reductions in air pollutants such as NOx and Particulate Matter. I am concerned that the EPA's budget asks to eliminate funding for this very successful program. Can you please explain how the Agency will make new gains in reducing air pollution from diesel engines and how the Agency will ensure continuing public health and environmental benefits from such air pollution reductions?

Answer: The EPA must make difficult choices to prioritize its activities. While the DERA grants accelerate the pace at which dirty engines are retired or retrofitted, pollution emissions from the legacy fleet will be reduced over time without additional DERA funding as portions of the fleet turnover and are replaced with new engines that meet modern emission standards. However, even with attrition through fleet turnover, approximately 1.5 million old diesel engines would still remain in use in 2030. Ongoing projects will continue to clean the air and support jobs during FY 2015, as the Agency continues to support and administer projects that have already received funding.

Question 5: The President's Executive Order on Chemical Safety directs the Federal Working Group to identify actions that will better protect people from hazards at chemical facilities. I recently held a hearing on the Executive Order and was concerned that the Working Group has identified few actions to improve oversight. I believe that we must move forward as rapidly as possible. Delay is unacceptable.

As a follow-up to the hearing, I asked the EPA witness to provide the Committee with a detailed explanation of how the Federal Working Group has met each of the required actions in the Executive Order and to provide the Committee with quarterly status updates on implementation of the Executive Order. Will you ensure that EPA responds to this request as soon as possible?

Answer: President Obama issued Executive Order (EO) 13650 - *Improving Chemical Facility Safety and Security* on August 1, 2013, to enhance the safety and security of chemical facilities and reduce risks associated with hazardous chemicals to facility workers and operators, communities, and responders. The Executive Order directed Federal departments and agencies to:

- Improve operational coordination with, and support to, State and local partners;
- Enhance Federal agency coordination and information sharing;
- Modernize policies, regulations, and standards; and
- Work with stakeholders to identify best practices.

On June 6, the Working Group's report to the President, entitled *Actions to Improve Chemical Facility Safety and Security – A Shared Commitment* was released. The report highlights activities undertaken to improve chemical facility safety and security and provides a consolidated plan of actions to further minimize chemical facility safety and security risks. The Working Group has implemented a number of actions since the release of the EO. A description of these actions can be found at: https://www.osha.gov/chemicalexecutiveorder/EO_Fact_Sheet_060514.pdf. Regarding periodic updates, EPA plans to continue to provide the Committee with regular updates on actions implemented under EO 13650.

Question 6: In December 2008, a devastating coal ash spill occurred in Kingston, Tennessee. More recently, an EPA-listed high hazard coal ash impoundment at a Duke Energy facility in North Carolina spilled into the Dan River threatening drinking water supplies down river from the facility. How will the Agency ensure that when it completes final rules concerning the disposal of coal ash later this year that there are adequate federal protections in place to protect communities near coal ash impoundments from this hazardous material?

Answer: The Agency is continuing to review and analyze more than 450,000 comments on the proposed Coal Combustion Residuals (CCR) rule. These comments raised a number of complex issues. In addition, EPA has solicited and received additional technical data. EPA continues to work to address these issues and will finalize the rule pending a full evaluation of all the information and comments received.

On May 2 of this year, a consent decree was entered, which establishes a deadline for EPA to take final action on the CCR proposed rule by December 19, 2014. The Agency plans to meet this deadline.

Question 7: EPA's Office of Inspector General recently completed an investigation of EPA's actions in the Parker County, Texas groundwater contamination case. OIG found that EPA acted appropriately when it issued an emergency order in that case, and when EPA lifted the order after the State agreed to investigate. However, OIG questioned the quality of data provided by Range Resources and whether residents in the community may still have unsafe drinking water. EPA agreed to take specific steps in response to the OIG's recommendation, including requesting additional information from Range Resources. Can you please provide an update on the status of EPA's implementation of the OIG's recommendations?

Answer: EPA has completed corrective actions addressing the Office of Inspector General's recommendations regarding the Range Resources matter. As part of these actions, the EPA requested, and Range Resources provided, additional quality assurance/quality control data associated with sampling undertaken by the company. The agency shared that data with the Texas Railroad Commission, the lead state agency charged with overseeing oil- and gas-related activities in Texas, on December 5, 2013, and at this time has not found any potentially significant data quality concerns. The EPA does not believe that the sampling data collected by Range Resources calls for further action by the EPA at this time.

Question 8: According to the Agency indoor radon is the nation's second leading cause of lung cancer and causes about 21,000 deaths each year. About one in 15 American homes contain high levels of radon. I am concerned that EPA's budget would cut funding for state and tribal grants to address this preventable cause of cancer. Can you please explain how the Agency will ensure that the public is properly protected from the threat of radon and how the public will have continued access to state and tribal programs that can assist them in reducing their risk of exposure to dangerous levels of radon?

Answer: Eliminating the State Indoor Radon Grants (SIRG) program is an example of the hard choices the Agency has made in this budget to help meet the nation's fiscal challenges. The Radon Program will continue to be a priority for the EPA and will continue to focus on radon risk reduction in homes and schools. The EPA will engage in public outreach and education activities, encourage radon risk reduction as a normal part of doing business in the real estate marketplace, promote local and state adoption of radon prevention standards in building codes, and participate in the development of national voluntary standards (e.g., mitigation and construction protocols) for adoption by states and the radon industry.

The EPA will drive action at the national level with other Federal agencies (through the Federal Radon Action Plan) to reduce radon risk in homes and schools using partnerships with the private sector and public health groups, information dissemination, participation in the development of codes and standards, and social marketing techniques. These actions are aimed at fixing homes and schools when radon levels are high and building new homes and schools with radon resistant features.

Question 9: I have been a strong supporter of EPA working to protect children's health from dangerous air and water pollution. EPA's budget increases environmental justice funding to improve environmental conditions in minority and low-income communities across the country and to enhance enforcement of clean air and other protections in at-risk communities, near schools and in other areas where children may be exposed to toxic pollution. Can you please describe how the Agency will use this budget request to strengthen environmental protections for these communities and enhance the environmental health of the country's most vulnerable populations?

Answer: The requested resources will deliver direct support and technical assistance to communities with environmental justice concerns and their partner organizations that are working to directly address the adverse environmental and public health issues impacting their residents. The emphasis will be on addressing the most vulnerable populations such as children and the elderly, and ensuring greater environmental protection and achieving visible differences in these communities. The request will also be used to increase outreach as well as collaboration and leveraging of resources between stakeholders (other federal agencies, state/local government, business, and NGOs) involved in community-based activities. This will include educating partners about aligning their community-based resources and investments while also supporting the capacity of these communities to address pollution problems.

These efforts also include further integration of the Agency's community-based efforts and investments (Tribal, Brownfields, Superfund, Air Toxics, Urban Waters/Green Infrastructure, and Sustainable Communities) in minority and low-income communities with environmental justice issues, to maximize community benefits and provide greater protection and tangible benefits as a result of these programs. For example, activities could include working with colleagues in other EPA offices to better align Agency brownfield site investments to include elements of green infrastructure which are also part of a community-focused area-wide planning initiative. Additionally, in past years, EJ assistance efforts to over 1,000 communities through various grant programs and technical assistance to approximately 30-40 communities through the Technical Assistance Services to Communities (TASC) contract, have enhanced their abilities to actively participate in decision making processes that affect their communities and broadened their skills and capacity to effect environmental changes such as remediation, clean up, education and research, the benefits of which is a healthier environment.

Question 10: In December 2013, in response to the OIG's Early Warning Reports in the John Beale fraud case, the EPA has taken a number of corrective actions to prevent future occurrences of such fraud. Can you please confirm your commitment to providing regular updates on the progress the Agency has made in addressing the issues raised in the OIG's report?

Answer: Yes, the EPA is pleased to confirm its commitment to providing updates. At this time, we can report a prompt and proactive effort that has produced substantial progress. In December 2013, the EPA released the *Report of Evaluation and Corrective Actions* which identifies areas where the Agency was taking, has taken, or was considering taking corrective actions. In April 2014, the EPA completed a second, more thorough review of issues in its *Report on Internal Control Assessments of EPA's Sensitive Payment Areas*. This report used GAO-standard procedures¹ for assessing internal controls, looking at seven areas: executive payroll approvals; employee departures; statutory pay limits; parking and transit subsidies; retention incentives; travel reimbursements; and executive travel approval. This report was provided to the EPA's Inspector General on April 17, 2014. While work continues to implement and ensure ongoing compliance with corrective actions, the Agency is working aggressively to prevent future fraud. The Agency will be pleased to continue to report on future progress.

¹ <http://www.gao.gov/greenbook/overview>

Questions Submitted for the Record by Senator Markey

Question 1: It's been nearly 4 years since the Deepwater Horizon drilling rig sank into the Gulf of Mexico causing an environmental catastrophe at a magnitude never seen in this country. In our frantic response to the oil that was gushing into the Gulf we used unprecedented amounts of chemical dispersants over an extended period of time. We also applied these dispersants under the water, in a way they were never intended to be used. Concerns about the toxicity and environmental impacts of the primary chemical dispersant used, known as Corexit, led the EPA to announce that it would be doing additional research and would propose changes to the list of approved chemical dispersants and other remediation agents.

a. When can we expect that these changes will be published?

Answer a: EPA expects to publish proposed revisions to the regulatory requirements associated with dispersants in summer 2014.

b. Will these changes incorporate the results of the impacts of prolonged and/or subsurface use of dispersants?

Answer b: Yes, the changes will address prolonged and/or subsurface use of dispersants.

Question 2: The NPDES permit for the Pilgrim Nuclear Power Station has been administratively extended by EPA for almost 20 years. When will the EPA complete its work to update the permit in a comprehensive manner?

Answer: The EPA is working on developing a NPDES permit for the Pilgrim Nuclear Power Station with the goal of issuing a draft permit for public notice by the end of September 2014.

Question 3: In 2011, EPA granted a three-year exemption from regulation under the Clean Air Act for carbon emissions from bioenergy facilities. EPA then commissioned an expert panel of the Science Advisory Board to review the Agency's proposed bioenergy carbon accounting framework. They found that EPA's framework needed to account for the important ongoing role that forests play in sequestering atmospheric carbon dioxide and that we cannot automatically assume biomass energy is carbon neutral. Basically, you can't cut down a 150 year old forest, burn it, and assume there's no net carbon impacts. In 2012, my home state of Massachusetts published final carbon accounting regulations using a methodology very similar to those recommended by the Science Advisory Board. Does EPA plan to incorporate these key science-based recommendations into whatever new rules are established to govern carbon emissions from bioenergy?

Answer: As detailed in the President's Climate Action Plan, part of the strategy to address climate change will include fostering expansion of renewable resources and responsible forest

management. A science-based approach to considering biogenic CO₂ emissions is a priority for the EPA. While the technical and methodological considerations are complex, the Agency is continuing to explore an approach that is based on a variety of factors. We appreciate that stakeholders are interested in an approach which allows for consideration of the unique attributes of biogenic feedstocks (as compared to other feedstocks such as coal) as a way to provide certainty and flexibility in the permitting context. The EPA is considering the range of approaches, supported by the science, that provide such opportunities. Currently, the EPA is working on revisions to the 2011 Framework that respond to the Science Advisory Board's comments and also consider the latest scientific analyses. In addition to the technical analyses, the EPA is evaluating the policy and legal implications of the range of approaches.

Questions Submitted for the Record by Senator Vitter

Topic: John Beale and Internal Controls

Question 1: During the hearing, you attributed the time lapse between when you first learned of John Beale's illegal bonus and when you finally cancelled the bonus to "it taking a while to get to the bottom of the John Beale issue because he was a criminal that had systemically intended to defraud the agency." The January 12, 2011 memorandum you received from Scott Monroe detailed both how "EPA policy requires that OAR recertify the bonus annually and re-establish the bonus every three years" and how "EPA had no records to show that these recertifications occurred except for one in 2000."

- a. Did it occur to you upon receipt of the January 12, 2011 memorandum that you had not ever signed annual certification paperwork for Beale's bonus despite having headed OAR at that point for a year and a half?

Answer: You are correct that during my time as Assistant Administrator of the Office of Air and Radiation, I did not recertify Mr. Beale's retention bonus. When I developed concerns about Mr. Beale's retention incentive I sought the assistance of senior managers responsible for human resources to review the incentive.

Question 2: On July 16, 2010, Scott Monroe sent Beth Craig an email which stated unequivocally, "Regardless of the circumstances surrounding overpayment, OAR must submit a request if we intend to continue the retention bonus."

- a. The email indicates that in order for Beale to continue to receive his bonus, it must be affirmatively recertified. Is this an accurate statement of EPA policy?
- b. Did your office recertify the retention bonus?
- c. If you were aware that he was receiving his bonus in error, and that they bonus had not been recertified, why did EPA continue to pay Beale the unearned wages?

Answer: The EPA retention incentive policy set forth in EPA Pay Administration Manual 3155 TN (June 1991) requires an annual "recertification" of any retention incentive whether established for a period of one, two, or three years, to ensure the conditions under which the original incentive was granted are still valid. Unfortunately, as the Beale case illustrated, the annual recertification requirement was not well understood by requesting officials. The EPA has now implemented a number of internal controls and policy changes to ensure retention incentive pay justification and recertification requirements are clearly understood by requesting officials and receiving employees.

During my time as Assistant Administrator, the Office of Air and Radiation did not recertify Mr. Beale's retention bonus. When I developed concerns about Mr. Beale's retention incentive, I sought the assistance of senior managers responsible for human resources to review

the incentive. Under the circumstances, it was prudent to verify information before acting on it. Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture.

Question 3: The January 12, 2011 memorandum you received from Scott Monroe also noted that retention incentives require a showing that there exists a "'special agency need' to retain the employee's services" and a showing that the employee is "'likely to leave,'" a showing which requires a written offer for outside employment, both of which Monroe suggested that Beale "did not appear to meet." Despite these obvious shortcomings, you allowed more than two years to pass before cancelling the bonus in February of 2013. During this time, Mr. Beale collected more than \$90,000 in unearned bonuses.

- a. Why was further investigation before cancelling his bonus necessary when Scott Monroe had already demonstrated that the lack of necessary recertifications since 2000?
- b. Why was further investigation before cancelling his bonus necessary when Scott Monroe had already indicated a lack of necessary documentation to meet the "likely to leave" requirement?
- c. Given the high standard for receiving retention incentives, did you—as Mr. Beale's direct supervisor—believe that there existed a "'special agency need' to retain" Mr. Beale's services? If not, why was further investigation before cancelling his bonus necessary?
- d. At the time you permitted the bonuses to continue, did you believe that Mr. Beale was "likely to leave" and had written evidence of outside job offers?

Answer: Neither OPM regulations nor EPA policy in place at the time required a written job offer to support a retention incentive. Having said that, I never authorized a retention incentive for Mr. Beale. Rather, when I developed concerns about Mr. Beale's retention incentive I sought the assistance of senior managers responsible for human resources to review the incentive. Under the circumstances, it was prudent to verify information before acting on it. While there was a delay in taking action, Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture.

Question 4: Despite the fact that you knew with certainty that the necessary criteria to receive a retention bonus had not been met two years before you took action to cancel the bonus, you had the audacity to assert the following: "What is true is I did pursue that issue [of Beale's illegal bonus] effectively, and I think the Agency was addressing it effectively."

- a. Please provide your definition of "effective."
- b. What would be an ineffective response to such clear warning signs?

Answer: When I developed concerns about Mr. Beale's retention incentive, I sought the assistance of senior managers responsible for human resources to review the incentive. Under the circumstances, it was prudent to verify information before acting on it. While there was a delay in taking action, Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture.

Question 5: What is the foundation of your claim that EPA responded to the issue of Beale's illegal bonus "effectively" when it was allowed to continue without the necessary recertification for more than a decade, during the last two years of which multiple officials were aware of its failure to meet multiple necessary criteria?

Answer: When I developed concerns about Mr. Beale's retention incentive, I sought the assistance of senior managers responsible for human resources to review the incentive. Under the circumstances, it was prudent to verify information before acting on it. While there was a delay in taking action, Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture.

Question 6: During the hearing, you responded to one of my questions ("Why, in early 2011 were you reluctant to finalize, to not cancel the bonus? Why were you reluctant to take action?") with the following response: "Actually, I understood that the issue was going to be referred to the Office of the Inspector General." According to the documents made available to the Committee, the first mention of even potentially referring the Beale matter to the OIG occurred only in spring of 2012.

- a. Were you in fact aware of plans to refer the Beale matter to the OIG in 2011?
- b. If so, please provide a detailed description of when and from whom you first heard of plans to refer Beale's compensation issues to the OIG, of whom you were aware had knowledge of the possibility that the Beale matter might be referred to the OIG, and of what you believed came of this plan to refer the matter to the OIG. Please also provide all documentation predating April 1, 2012 in your possession referring to Beale and the OIG in conjunction with each other.
- c. If you incorrectly stated that you believed that the matter was to be referred to the IG, then why in fact were you reluctant to finalize the cancellation of Beale's bonus in early 2011?

Answer: When I developed concerns about Mr. Beale's retention incentive I sought the assistance of senior managers responsible for human resources to review the incentive. Similarly, I sought assistance when I became concerned about Mr. Beale's attendance record. Under the circumstances, it was prudent to verify information before acting on it. While there was a delay in taking action, Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture.

Question 7: During the hearing, I quoted from an email produced to me by the OIG from Susan Smith, a Team Leader in the Executive Resources Division of the Office of Administration and Resource Management, to Karen Higginbotham, the Director of the Executive Resources Division. In the email, Ms. Smith attests to Ms. Higginbotham that "Scott Monroe stopped by ... and said that Gina is reluctant to finalize [the cancellation of Beale's retention incentive bonus] unless OARM (Craig) gives her the okay that the White House is aware and there will not be any political fallout." You not only expressed unfamiliarity with the email and represented that you had never had a conversation with Ms. Smith, but also asserted that: 1.) you had never spoken with Scott Monroe about the White House in regards to the Beale bonus matter, 2.) you were never concerned "that the White House would look at political fallout," and 3.) you "never had concerns about the White House's interference."

- a. Have you ever communicated with anyone at the White House about the Beale matter? If so, please describe these communications to the best of your ability, including the date of the interaction and the individual with whom you interacted. If any documentation exists of such communications, please provide them to the Committee.
- b. Did you ever communicate with Craig Hooks, Scott Monroe, or anyone else about the White House in connection to John Beale's misconduct? If so, please describe these communications to the best of your ability, including the date of the interaction and the individual with whom you interacted. If any documentation exists of such communications, please provide them to the Committee. If not, was Mr. Monroe fabricating these concerns?
- c. Have you ever been concerned about the potential for "political fallout" from the Beale investigation? If so, what sort of "political fallout"? Please describe in detail.
- d. Were you aware of anyone within EPA, or the Obama Administration more broadly, who was concerned about the potential for "political fallout" from the Beale investigation? If so, please identify these individuals and your impressions of their concerns.
- e. Were any of your actions in the investigation of Beale's misconduct shaped by the potential for "political fallout"?
- f. Why did you tell the OIG that the only "political fallout would have been during your confirmation hearing"? Were you concerned that Beale would be an obstacle to your confirmation as EPA Administrator?

Answer: I did not consult with anyone in the White House about the appropriate course of action to take in response to John Beale's pay and attendance issues. While an incident of this nature can lead to questions during the confirmation process and Mr. Beale's misconduct has been the focus of multiple Congressional Oversight hearings and requests, this level of attention occurred after the retention incentive was cancelled and after the matter was referred to the Office of Inspector General.

When I developed concerns about Mr. Beale's retention incentive and his attendance record, I sought the assistance of appropriate EPA employees. Under the circumstances, it was prudent to verify information before acting on it. This was not based on a concern about political fallout, but on a desire to verify Mr. Beale's status. While there was a delay in taking action, Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture.

Question 8: During the hearing, you challenged my criticism of Beale being allowed to retire by noting that "every employee has their right to retirement" and that you are "sure he exercised that right."

- a. Did you have cause to fire Beale in April 2013?
- b. Did Mr. Beale have a "right" to retire?
- c. Does every EPA employee facing potential discipline and/or termination have the "right" to retire with full benefits first?

Answer: Although EPA management was aware in April 2013 of information pointing to serious misconduct on the part of Mr. Beale, at that time his misconduct was also the subject of an EPA Office of the Inspector General (OIG) investigation. As is customary, once the EPA referred the matter to the OIG for investigation and learned the matter may result in criminal prosecution, the EPA prioritized the criminal investigation and deferred administrative action until the OIG completed its review and provided a final report to the EPA.

A Federal employee's ability to retire – even in the face of potential disciplinary action – is controlled by Federal law, not EPA policy. An employee, like Mr. Beale, who is eligible to retire under the applicable statutes and regulations, may submit an application for retirement which is ultimately approved or disapproved by the Office of Personnel Management. EPA has no authority to prevent a retirement eligible employee from applying for retirement.

Question 9: During the hearing, you also challenged my criticism of Beale being allowed to retire by noting that he is currently in federal prison. This suggests that you view prosecution by the Department of Justice as a sufficient substitute for adequate internal EPA controls and actions. Is that an accurate reflection of your views?

Answer: The EPA has internal controls in place, and we are working to update these controls as well as to improve clarity and accountability. These improvements are being actively integrated into the Agency's processes. In April, the EPA completed its *Report on Internal Control Assessments of EPA's Sensitive Payment Areas*. This report used GAO-standard procedures for assessing internal controls, identified deficiencies, and proposed corrective actions along with estimated completion dates for those actions.

The overwhelming majority of the approximately 16,000 EPA employees are dedicated, hardworking, professional public servants. Nonetheless, it is absolutely essential that EPA develop and maintain internal controls that ensure the accurate reporting of time and attendance and the fair and appropriate application of all EPA human resource policies.

Question 10: How many EPA employees have been terminated during your tenure as Administrator? How many employees within the Office of Air and Radiation were terminated during your time as Assistant Administrator?

Answer: According to Agency records, from July 18, 2013 (Gina McCarthy's confirmation as Administrator to the EPA) until May 1, 2014 (date of data pull), 11 EPA employees have been terminated. From June 2, 2009 (Gina McCarthy's confirmation as Assistant Administrator to the Office of Air and Radiation) until July 18, 2013 (Gina McCarthy's confirmation as Administrator to the EPA), 8 Office of Air and Radiation employees were terminated.

Question 11: During the hearing, you responded to a question from Senator Whitehouse by describing Beale as an outlier who is not representative of the EPA workforce. Nevertheless, you told the OIG that "Beale 'walked on water at EPA' due to his work on the [Clean Air Act] and other policy issues in the early 1990s." Furthermore, during your time as his direct supervisor as Assistant Administrator, you effusively praised Beale in emails to the entire Office of Air and Radiation. Additionally, even as Beale was sentenced to 32 months in federal prison for his crimes, he was offered strong support from a number of current and former senior EPA employees. They submitted letters, which went much further than calling him "a good man." Indeed, they called him a "tower of fortitude" and a man whom they still "respected ... immensely." One former colleague even said that "John is still one of the five people I would speed dial for help." How do you reconcile your claim that Beale was an outsider and not representative of the employees at EPA within the Office of Air and Radiation, with the praise offered by senior EPA officials on Beale's behalf even after he was exposed?

Answer: All of us at the EPA were offended by the fraudulent actions of Mr. Beale. He was an outlier in that the overwhelming majority of 16,000 EPA employees are dedicated, hardworking, and professional public servants, well-deserving of the public trust placed in the Agency.

Question 12: As Assistant Administrator for OAR, you sent multiple staff-wide emails praising Beale's performance. In one email you referred to his frequent absences from work and stated "we are keeping him well hidden so he won't get scooped away from OAR anytime soon." Yet, you told the OIG that you had suspicions over Beale from the moment you started at EPA.

- a. Why did you believe he was such an exemplary employee?

- b. Why didn't you take any meaningful action on your suspicions?
- c. In light of your professed concerns over Beale from the moment you started at EPA, did you worry about the kind of example Beale set for other EPA employees?

Answer: Mr. Beale contributed legitimately to the work of the Agency during much of his career and I was unaware of his fraudulent conduct when I first joined the Agency in 2009. When I developed concerns about Mr. Beale's retention incentive and his time and attendance reporting, I sought the assistance of the appropriate EPA employees. Under the circumstances, it was prudent to verify information before acting on it. Mr. Beale is now serving over two years in prison for his criminal fraud and has, to date, paid the government nearly \$900,000 in restitution and \$500,000 in forfeiture. The overwhelming majority of the approximately 16,000 EPA employees are dedicated, hardworking, professional public servants.

Question 13: What verification mechanisms exist to ensure that employees do not continue collecting paychecks after they stop working?

Answer: The EPA has procedures in place to handle employee separations in situations of death in-service, retirement, and other separations. In the case of separations other than due to death or retirement, the Agency follows a five-step process that, among other things, ensures employees do not continue collecting paychecks after they stop working. These steps are:

Step 1: Program Offices Issue SF-52 (Request for Personnel Action) to HR Shared Services Center (HR SSC);

Step 2: HR SSC Processes SF-52 and issues SF-50 (Notice of Personnel Action);

Step 3: HR SSC Prepares Benefits Separation Package;

Step 4: HR SSC Issues Separation Notice to the Defense Finance and Accounting Services (DFAS), et al.; and

Step 5: Offices follow Time and Attendance Procedures if not immediately removed from payroll.

In April 2014, the Agency also identified other steps to further ensure payments do not continue after employee separation (elimination of default pay and elimination of mass approval). These improvements are being integrated into the Agency's processes. In the event of inappropriate pay after separation, the Agency has and will continue to issue debt collection notices for any overpayment.

Finally, EPA is working on measures to increase clarity and accountability. These measures will include issuing an Executive Approval Framework and other guidance to notify employees and supervisors of the need to accurately submit and verify time and attendance.

Question 14: How many cases of suspected time and attendance fraud have you been made aware of during your tenure as Administrator? How many suspected instances have been

referred to you from an external source, and how many were discovered by you and those you supervise?

Answer: Where an instance of time and attendance fraud is suspected, EPA encourages such suspicion and any supporting information to be referred to the individual's supervisor and the EPA Office of Inspector General.

Question 15: How many cases of suspected time and attendance fraud had you been made aware of during your tenure as Assistant Administrator for the Office of Air and Radiation? How many suspected instances have been referred to you from an external source, and how many were discovered by you and those you supervise?

Answer: Where an instance of time and attendance fraud is suspected, EPA encourages such suspicion and any supporting information to be referred to the individual's supervisor and the EPA Office of Inspector General.

Question 16: Beale spent hundreds of thousands of taxpayer dollars on excessive travel. Yet, EPA employees signed off on his erroneous travel vouchers because they thought he was "special."

a. How much money does EPA spend on travel?

Answer a: In the FY 2015 President's Budget, the EPA budgeted \$42.2 million for personal travel, which is a 30% decrease from budgeted personal travel in the FY 2010 enacted budget. Recent EPA travel budgets have been historically low as demonstrated in the table below. In the past five fiscal years (FY 2011-FY 2015), the EPA budgeted personal travel has not exceeded \$44 million, while from FY 2006 to FY 2010, budgeted personal travel ranged from \$54-\$60 million.

The reduction in EPA's travel budget has been achieved through a decrease in the number of face-to-face meetings and increased use of video and teleconferencing. Recognizing tight government budgets, EPA has been judiciously reserving travel funds for priority travel and using technology whenever possible.

Budgeted Travel: FY 2010-FY 2015
(Dollars in Thousands)

	FY 2010 ENA	FY 2011 ENA	FY 2012 ENA	FY 2013 ENA	FY 2014 ENA	FY 2015 PB	% change '10 EN to '15 PB
Travel, Personal	\$60,507	\$37,770	\$43,944	\$38,451	\$38,549	\$42,239	-30.2%

b. Is there really a different standard for certain EPA employees' travel?

Answer b: The General Services Administration (GSA) promulgates the General Travel Regulation, which applies to agencies Federal Government-wide. Under that regulation and GSA guidance, there are certain circumstances where Agencies are authorized to approve special classes for employee travel. For example, "other than coach- class" may be used for air travel when it is "necessary to accommodate a medical disability or other special need." 41 CFR 301-10.123. The EPA's policies regarding official travel are consistent with GSA rules and guidance.

c. Who else is "special" at the EPA that can get away with this?

Answer c: All EPA employees, without exception, are expected to comply with applicable laws and regulations. In addition, the EPA has made several key improvements to our travel policies and procedures in an effort to prevent the type of fraud committed by Mr. Beale from being committed again.

Question 17: What is the process by which time and attendance problems are dealt with?

Answer: As the EPA Office of Inspector General's website² explains, the Agency's appropriate response to a time and attendance problem will vary based on the particular problem identified. Where an instance of time and attendance fraud is suspected, the EPA encourages such suspicion and any supporting information to be referred to the individual's supervisor and the EPA Office of Inspector General.

Question 18: As an organization, would you characterize the EPA as having a culture that values attention to proper time and attendance keeping?

Answer: Absolutely. The EPA's employees are generally honest and conscientious about proper time and attendance keeping, and well deserving of the public trust placed in the Agency.

Question 19: According to the Corrective Action Report of December 2013, EPA is migrating to a new payroll system in 2014. Please describe this new system. What features does it offer over the current system? Is the transition on schedule? How much did it cost?

Answer: The Department of the Interior's Interior Business Center (IBC) is an Office of Management and Budget and Office of Personnel Management approved Human Resources Line of Business (HRLoB) Shared Service Center. Interior Business Center's Federal Personnel/Payroll System (FPPS) is an integrated human resources and payroll system used by numerous federal government entities. FPPS implements all current regulations, including specialized pay, garnishments, special appointment programs, and other payroll related functions.

² <http://www.epa.gov/oig/>

FPPS integrates HR and payroll functionalities which was previously split between two separate systems at EPA, PeoplePlus and Defense Civilian Payroll System (DCPS). PeoplePlus was the HR system of record for EPA performing functions such as new hires, promotions, details, and separations. With the migration, PeoplePlus will no longer perform the HR services, serving only as the Time and Attendance system. EPA's former payroll provider was Defense Finance and Accounting Service (DFAS), and their payroll system is DCPS. This system has been fully replaced by FPPS.

Before migrating to this system, EPA relied on separate systems for HR processing and payroll processing, which required EPA to maintain a technical interface between the systems. In the past, HR and time & attendance data was sent from PeoplePlus to DFAS. Now, only time and attendance data is sent. Also, HR actions are input directly into the integrated FPPS system. In the past, HR actions were input into PeoplePlus and then sent at a later time through the interface to DFAS. This lag has been eliminated.

In addition, human resources related processes are now automated in the new system, which were formerly paper based. These features result in more accurate and faster processing of HR related actions. For example, one benefit of FPPS is that it provides the ability to stop retention incentive payments automatically by entering into the system the end date of the incentive payment.

The migration of EPA's HR and payroll services to IBC's FPPS system was implemented in June 2014 on schedule. The estimated fees that IBC will charge EPA for FY 2014 is \$2.1 million and \$4.4 million in FY 2015.

Question 20: According to the Corrective Action Report of December 2013, "Currently, the EPA is implementing a policy of "default pay" and "mass approval," where an employee will be paid for a full 80 hours over a pay period even if one step of the process fails to occur." Please explain the rationale behind this policy and how long has it been in effect.

Answer: Beginning in 2004, the EPA began using a time approval system that allowed for group approval (which allowed a manager to approve a group of employees at once), mass approval, and default pay. The group approval capability was removed in 2013, and the EPA is now implementing new approval mechanisms that will not allow for mass approval or default pay.

Question 21: According to the Corrective Action Report of December 2013, "the EPA also amended its time and attendance policy on June 20, 2013, and is currently engaged in negotiations with the agency's unions over the revised policy." Please detail the status of these negotiations.

Answer: Two EPA unions, ESC (Engineers and Scientists of California) and NTEU (National Treasury Employees Union), sought to negotiate over the changes to the time and

attendance policy. The agency resolved all issues with ESC in November, 2013 and with NTEU in January, 2014.

Question 22: According to the Corrective Action Report of December 2013, EPA said that it "expects to complete its review" of executive payroll approvals, employee departures and payroll, statutory pay limits, parking and transit subsidy, retention incentives, travel other than coach class travel, travel reimbursements above the government rate, and executive travel approval. According to this report, the reviews were supposed to be finished within 4 to 12 weeks. What is the status of each?

Answer: In April 2014, the EPA completed a review of each of these issues in its *Report on Internal Control Assessments of EPA's Sensitive Payment Areas*. This report used GAO-standard procedures³ for assessing internal controls looking at all of the areas mentioned above, identified deficiencies, and proposed corrective actions along with estimated completion dates for those actions. On April 17, 2014, we delivered this Report to the EPA Office of Inspector General.

Question 23: According to the Corrective Action Report of December 2013, no EPA employees were then receiving a retention incentive. Is this still the case? When was there a major reduction in the number of people receiving them? Are they still available?

Answer: At present, there are no EPA employees receiving a retention incentive. Use of retention incentives at EPA has always been rare; only 28 employees have received such incentives since 1990. Previous retention incentives have ended through expiration, termination, or change in the employment status of the employee. While no employees are currently receiving a retention incentive, the program is available if incentives are properly justified, reviewed and approved.

Question 24: According to the Corrective Action Report of December 2013, "regulations also provide agencies with the ability to request a waiver from OPM of these caps up to 50% of an employee's salary." Are you aware of instances where an EPA employee exceeded the cap by 50%? What is the largest waiver you have encountered?

Answer: I am not aware of any instances in which EPA has sought this type of waiver and therefore there is no incident when a large waiver was encountered.

Question 25: How many EPA employees are currently receiving salaries that are above the statutory cap and require a waiver?

Answer: There are no EPA employees receiving salaries above the statutory cap.

Question 26: Please identify the position of every employee of the EPA who has exceeded the statutory pay cap during your tenure as Administrator, indicate by how much that employee exceeded the salary cap, and whether that employee received a proper waiver to do so.

³ <http://www.gao.gov/greenbook/overview>

Answer: Generally, there are three pay limitations applicable to federal employees. First, employees have a bi-weekly limit to pay. Second, employees are subject to an annual maximum earnings limitation which includes basic pay and premium pay. Finally, there is an aggregate limit to pay which includes annual basic pay plus premium pay, awards, allowances, and differentials.

No EPA employees have been paid beyond the aggregate limitation on pay (5 U.S. Code 5307 and 5 Code of Federal Regulations 530.203) during the Administrator's tenure. Further, there is no statutory basis for making an exception or waiver to the limitation (which is the pay rate of Executive Level I), and EPA compensation has not exceeded that limitation.

Relative to the annual maximum earnings limitation (5 U.S. Code 5547 (b) (2) and 5 Code of Federal Regulation 550.107), an exception may be made for premium pay work in conjunction with U.S. military contingency operations in designated locations and countries. EPA has experienced only one case of a claim for granting an exception to the annual maximum earnings limitation. For that single instance, an employee performed substantial premium pay work while on detail (under an interagency agreement to the U.S. Army Corps of Engineers) in Iraq during the latter half of 2012 and first half of 2013. The employee's basic pay plus premium pay compensation entitlement exceeded the annual maximum earnings limitation. EPA is presently conducting a thorough review of the claim to ensure accurate accounting and has not yet determined the full claim amount for that 2013 exception.

Question 27: Please identify the position of every employee of the Office of Air and Radiation who exceeded the statutory pay cap during your tenure as Assistant Administrator. Please also indicate by how much that employee exceeded the salary cap, and whether that employee received a proper waiver to do so.

Answer: During Gina McCarthy's tenure as Assistant Administrator of the Office of Air and Radiation (June 4, 2009 to July 18, 2013), there were no employees compensated beyond the annual maximum earnings limitation. The compensation of one employee, Mr. John Beale, exceeded the aggregate limitation (5 USC 5307) by \$5,920.00 and \$6,105.00, respectively in FY 2009 and FY 2010. Mr Beale received no waiver for the exceedance and has subsequently paid back all overpayments to the government.

Question 28: How many EPA employees have received subsidized parking during your tenure as Administrator? Please provide as specific of an answer or estimate as possible.

Answer: Approximately 290 EPA headquarters employees have received subsidized parking at the federal triangle complex at some point during 2013 or 2014.

Question 29: How many Office of Air and Radiation employees received subsidized parking during your tenure as Assistant Administrator? Please provide as specific of an answer or estimate as possible.

Answer: Approximately 76 EPA Office of Air and Radiation employees received subsidized parking at the federal triangle complex at some point between 2009 and 2013.

Question 30: On March 19 of this year, the Committee's minority staff published a 67-page report entitled *EPA's Playbook Unveiled: A Story of Fraud, Deceit, and Secret Science*, which documents how Beale coordinated abusive tactics in the rulemaking process behind the 1997 Ozone and Particulate Matter National Ambient Air Quality Standards and how the EPA adopted this system that he pioneered in numerous subsequent air quality regulations. In news reports, EPA representative Alisha Johnson downplayed Beale's role: "While Mr. Beale did work on the rules mentioned in the report, he was just one of a large number of people from a number of disciplines across the Agency who provided input on those rules."

- a. Is it not true, though, that Beale's bonuses and promotions were based in large part on his "key role" on one of the "most significant issues he managed": the 1997 Ozone and Particulate Matter NAAQS?
- b. Is it not true that in a staff wide email sent on December 3, 2010, you praised Beale for his "leading role" in the 1997 NAAQS review?
- c. In light of these incontrovertible facts, why is EPA now downplaying the role that even you claimed he had in setting the 1997 NAAQS?

Answer: While I was not with the U.S. EPA in 1997 or at the time Beale received his promotions or his first retention bonus, my understanding is that these were based on his legitimate work for the Agency.

Each review of the National Ambient Air Quality Standards (NAAQS) is an incredibly complex, technical and resource-intensive undertaking based on sound science and legal standards. While Beale played a visible role through his position at that time in the Office of Air and Radiation, his involvement in no way undermines the rational basis for the Agency's decisions nor the integrity of the administrative process. These rules were reviewed in the Supreme Court, which concluded in 2001 that costs of implementing the standards could not be considered in setting the standards. The PM standard was entirely upheld by the courts, and the ozone standard was upheld (with one small exception which did not require any changes in the standard). Since that time, both standards have been re-reviewed by the EPA.

Question 31: In EPA's justification for its proposed FY 2015 budget, the Agency requests Congress extend its authority under Title 42 to hire individuals to science and research positions at salary levels above the general service employee pay limit.

- a. Please list the employees who were hired under Title 42?

Answer a: The table below provides EPA's current on-board Title 42 employees.

FY Hired	OPM Position Classification	EPA/ORD Organization	Science Expertise
2006	Research Chemist (Bioinformatics)	National Center for Computational Toxicology (NCCT), Research Triangle Park, NC	<ul style="list-style-type: none"> Leads cutting-edge research in systems models of cellular behavior. International expertise in bioinformatics and predictive biochemical pathways.
	Research Physicist (Computational Systems Biology)	NCCT, Research Triangle Park, NC	<ul style="list-style-type: none"> Heads innovative research in developing complex computational solutions to use models to characterize chemical exposure, hazard, or risk, such as ToxCast. International leadership in creating informatics teams and in the area of genomics.
	Research Biologist (Systems Biology)	National Health and Environmental Effects Research Laboratory (NHEERL), Integrated Systems Toxicology Lab, Research Triangle Park, NC	<ul style="list-style-type: none"> Leads the lab in initiating systems approaches in developing molecular biology methodologies. International leadership in combining experimental and computational approaches to health effects of environmental contaminants.
2007	Research Biologist (Developmental Systems Biology)	NCCT, Research Triangle Park, NC	<ul style="list-style-type: none"> Heads ORD's research to develop complex systems level models of biological processes and tissues. Provides international expertise in developmental biology, systems biology, genomics, and computational modeling.
2007	Supervisory Research Biologist (Director)	NHEERL/Environmental Public Health Lab/Clinical Research Center, Research Triangle Park, NC	<ul style="list-style-type: none"> Leads ORD's research on pulmonary effects related to air pollution and sensitivity factors. Brings international experience in the area of assessment and characterization of immunological and allergic diseases in response to air pollution.
2008	Supervisory Research Biologist (Director)	National Center for Environmental Assessment (NCEA), Research Triangle Park	<ul style="list-style-type: none"> Directs ORD assessment of the health and environmental effects of single environmental pollutants and combinations of pollutants.

FY Hired	OPM Position Classification	EPA/ORD Organization	Science Expertise
		Center, NC	<ul style="list-style-type: none"> Provides international expertise in health risk assessment and air pollutants research.
2010	Supervisory Chemist (Director)	National Risk Management Research Laboratory (NRMRL), Sustainable Technology Lab, Cincinnati, OH	<ul style="list-style-type: none"> Leads ORD's development and application of models and tools to prevent, mitigate, and control environmental risks. International expertise in green chemistry, engineering, and sustainability science.
2011	Supervisory Health Scientist (Director)	NHEERL, Environmental Public Health Lab, Research Triangle Park, NC	<ul style="list-style-type: none"> Heads ORD's integrated, clinical, epidemiological, and laboratory animal based research program. Brings international leadership in cardiac effects of air pollution on environmental exposure and risk identification and characterization.
2011	Supervisory Research Biologist (Director)	NHEERL Integrated Systems Toxicology Lab, Research Triangle Park, NC	<ul style="list-style-type: none"> Leads ORD's research in using systems biology approaches to describe normal biological, homeostatic processes and to identify key events that signal departure from those processes leading to adverse health outcomes. International leadership in toxicology, molecular biology, pharmacology, and genetics.
	Supervisory Biologist (Director)	NHEERL, Toxicity Assessment Lab, Research Triangle Park, NC	<ul style="list-style-type: none"> Directs ORD's integrated toxicology assessment research that incorporates developmental biology, reproductive biology, endocrinology, and neurosciences. Provides international expertise in in vivo toxicology, neurological biology, reproductive and developmental biology, and source to effects models.
	Supervisory Physical Scientist	National Exposure Research Laboratory	<ul style="list-style-type: none"> Heads ORD's research into fate and transport of environmental stressors,

FY Hired	OPM Position Classification	EPA/ORD Organization	Science Expertise
	(Director)	(NERL), Ecosystems Research Lab, Athens, GA	including studies of the behavior of contaminants, nutrients, and biota in environmental systems. <ul style="list-style-type: none"> • Provides international expertise in working with ecologists, chemists, fisheries biologists, geologists, and engineers.
	Supervisory Biologist (Director)	NERL, Microbiological and Chemical Exposure Assessment Research Lab, Cincinnati, OH	<ul style="list-style-type: none"> • Leads ORD's research on microbial ecology and the potential risk factors in natural and engineered water systems. • International leader in microbial ecology, chemistry, and physiology.
2012	Supervisory Biologist (Deputy Assistant Administrator for Science)	Office of the Assistant Administrator, Immediate Office, Washington, DC	<ul style="list-style-type: none"> • Leads all science and research in ORD. • Provides scientific foundation and leadership across ORD research programs. • International leader in the areas of developmental toxicology, endocrine disruption, benchmark dose analysis, and computational toxicology.
	Supervisory Biologist (National Program Director)	Air, Climate, and Energy National Research Program, Research Triangle Park, NC	<ul style="list-style-type: none"> • Provides the critical science to develop and implement the National Ambient Air Quality Standards under the Clean Air Act. The research program fosters innovative approaches to ensure clean air in the context of a changing climate and energy options. • Internationally recognized expert in the area of public health effects of air pollution, including inhalation and cardiovascular toxicology.
	Supervisory Biologist (National Program Director)	Safe and Sustainable Water Resources Research Program, Washington, DC	<ul style="list-style-type: none"> • Heads ORD's research on developing new approaches for evaluating groups of contaminants for the protection of human health and the environment; developing innovative tools, technologies, and strategies for

FY Hired	OPM Position Classification	EPA/ORD Organization	Science Expertise
			<p>managing water resources; and supporting a systems approach for protecting and restoring aquatic systems.</p> <ul style="list-style-type: none"> • Provides internationally recognized expertise in the areas of environmental sciences, toxicology, human health, and wetland restoration.
2012	Supervisory Environmental Engineer (Director)	National Center for Environmental Research, Washington, DC	<ul style="list-style-type: none"> • Leads and conducts highly recognized, leading edge, extramural research in the areas of exposure, risk assessment, and risk management. This includes supporting high-quality research by the nation's leading scientists and engineers that will improve the scientific basis for national environmental decisions. • Internationally recognized leader and expert in the area of environmental engineering, including hazardous waste management, treatment, and disposal.
	Supervisory Physical Scientist (National Program Director)	Chemical Safety for Sustainability, Washington, DC	<ul style="list-style-type: none"> • Provides the scientific foundation for the chemical safety for sustainability program in order to advance environmental sustainability. • Leads international innovation in areas of chemical design and chemical impacts to human health and the environment.
2012	Supervisory Biologist (Director)	NCEA, Washington, DC	<ul style="list-style-type: none"> • Leads ORD's health and ecological assessment program to determine how pollutants may impact human health and the environment. • Internationally recognized leader and expert in toxicology and environmental health sciences.

FY Hired	OPM Position Classification	EPA/ORD Organization	Science Expertise
	Supervisory Environmental Health Scientist (Director)	NERL, Human Exposure and Atmospheric Sciences Lab, Research Triangle Park, NC	<ul style="list-style-type: none"> • Heads ORD's research effort to develop innovative approaches for assessing the fate, transport, and exposure to air pollutants from different sources and develop and apply tools for assessing aggregate exposures and cumulative risk to all stressors from all sources. • Internationally recognized expert in the area of human exposure and atmospheric sciences.
2013	Associate Director for Health	NHEERL, Research Triangle Park, NC	<ul style="list-style-type: none"> • Leads NHEERL's health effects research program to assess the impact of chemical and other environmental stressors on human health that builds on systems biology thinking employing a variety of approaches such as in vivo, in vitro, and in silico technologies. • International recognition in the areas of gene regulation, toxicokinetics and toxicogenomics, and developmental toxicology.
	Supervisory Toxicologist (Director)	NCCT, Research Triangle Park, NC	<ul style="list-style-type: none"> • Heads ORD's research into the application of mathematical and computer models to technologies derived from computational chemistry, molecular biology, and systems biology. • Brings international leadership and experience in the areas of genomic biology, bioinformatics, and chemical safety sciences.
FY 2014	Supervisory Biologist (Director)	NRMRL, Kerr Lab, Ada, OK	<ul style="list-style-type: none"> • Leads NRMRL's research into the interactions of technical, economic, and social factors which affect current and future demands on water resources.

FY Hired	OPM Position Classification	EPA/ORD Organization	Science Expertise
			<ul style="list-style-type: none"> • International recognition on subsurface resources, water quality, nutrient cycling, and ecosystems research and management.

b. What is the salary range for current EPA employees hired under Title 42?

Answer b: The Title 42 salary range is from the GS-15 step 10, with locality pay, to \$250,000.

Question 32: In EPA's justification for its proposed FY 2015 budget, the Agency requests Congress remove the ceiling under Title 42, which limits the hiring of 50 persons to science and research positions at salary levels above the general service employee pay limit.

a. How many persons would EPA hire under Title 42 if there was no ceiling?

Answer a: As recommended by the National Academy of Sciences in its 2010 report on EPA's Use of Title 42, EPA would determine the number of people to hire under Title 42 based on our programmatic needs and available budget.

b. What area of science and research does EPA need more employees under Title 42?

Answer b: Title 42 appointments in the following fields, for example, would benefit research efforts across our research organizations and help provide the transformative innovative scientific leadership to meet the Agency's mission requirements:

- Systems biology
- Integrated modeling
- Exposure informatics
- Predictive toxicology
- Epidemiology
- Integrated chemical hazard assessment
- Ecology
- Methods development
- Life-cycle analysis

Topic: CASAC

Question 33: From March 25-27, 2014, the Clean Air Scientific Advisory Committee (CASAC) ozone review panel met to review national ambient air quality standards for ozone. The

composition of CASAC is not only critical to the impending ozone standards, but in the context of EPA's proposed FY 2015 budget, it is critical given the massive amount of federal research grants these panelists have received to produce work they are reviewing as CASAC panelist, essentially creating a scientific revolving door. Yet, the Agency has continued to deny public access to the underlying science at the same time it continues to issue more grants to the same researchers.

- a. In light of these facts, are you aware that 75% (15 out of 20) of the CASAC ozone review panelists have received EPA research grants?
- b. Are you aware that those 15 panelists have received over \$180.8 million in EPA research grants?
- c. Is this a conflict of interest? If not, why not?

Answer: The CASAC procedures and policies are transparent, publically available, and supported by its members. These policies assure that these advisory committees provide a balance of perspectives and appropriate scientific expertise. Procedures are in place to address issues such as conflict of interest, including public disclosure of any information that could create an appearance of bias. In seeking the best advice, the EPA looks to nationally and internationally renowned scientists to ensure the work we do is based on sound, credible science. These scientists are often cutting edge experts in the area of air pollution. Thus, it is no surprise that some compete successfully for research grants – from the EPA and from others such as NSF and NIH. OMB's peer review guidance explicitly recognizes that research grants that were awarded to the scientist based on investigator-initiated, competitive, peer-reviewed proposals, do not generally raise issues of independence.

Question 34: In our private discussions, prior to your nomination, you stated that "legitimate scientists" would be provided access to underlying data. How does the agency define a "legitimate scientist" and "legitimate scientific inquiry?"

Answer: There are many studies across the scientific disciplines that use publicly available data sets that are included in the Integrated Science Assessments (ISAs) for ozone and PM. The EPA maintains a comprehensive list of all studies included in these assessments in its publicly available Health & Environmental Research Online (HERO) database (<http://hero.epa.gov/>). In many studies, however, scientific protocols require that authors not report underlying data pertaining to personal confidential medical information to protect the privacy of study participants. The EPA understands that it is important to increase transparency and public access to information, but it also is essential to protect the privacy of individuals who have served as subjects in studies along with their personal health information. For this reason, research institutions that hold these data have detailed requirements and procedures for accessing their data. For example, the American Cancer Society (ACS) clearly states that investigators who are not employed in ACS' Epidemiology Research Program may request relevant data to conduct a study. There are, however, data access policies and procedures, which are clearly outlined at <http://www.cancer.org/acs/groups/content/@research/documents/document/acspc-039148.pdf>.

Topic: White House Inference with Congress

Question 35: On June 13, 2013, Kevin Minoli, Acting General Counsel, sent the White House an email asking for permission to release 106 emails to Chairman Issa and Ranking Member Vitter. These 106 emails were also subject to Ranking Member Vitter's negotiations over your confirmation as EPA Administrator. The EPA did not turn over these documents, and only did so AFTER Congress subpoenaed the documents. Accordingly, it appears that the White House acted to obstruct a Congressional investigation. Since the discovery of this email, Chairman Issa has issued a subpoena for all documents in EPA's possession that relate to this obstruction.

- a. Ms. McCarthy, according to an email obtained by the Committee – it appears that EPA sought White House permission to release 106 documents to me and Chairman Issa last June. EPA did not release these documents until Issa issued a subpoena in September 2013. Did the White House ever instruct you or EPA official to withhold these documents from Congress?
- b. Is it common practice for EPA to seek the White House's permission to respond to a Congressional request, even when White House equities are not involved?
- c. Did EPA do so in this case?
- d. Why did EPA refuse to turn over the documents in question until a subpoena had been issued?
- e. Why has EPA not complied with the most recent subpoena for documents relating to White House interference with a Congressional Investigation?

Answer: It is common practice for the EPA, in every administration to appropriately consult with various offices within the White House including the Council on Environmental Quality, the Office of Management and Budget, and the White House Counsel's Office. The EPA did consult with the Office of White House Counsel on this particular request for documents, though the ultimate decisions regarding appropriate handling of the documents were made by the EPA. The EPA respects Congress's important oversight role and strives to respond to all requests from Congress, regardless of whether those requests are made in the context of a letter or a subpoena.

Topic: New Source Performance Standards (NSPS)

Question 36: When EPA evaluated whether the cost of electricity from a new power plant using CCS is reasonable, did EPA rely on the cost of the technology at its current status as an emerging technology for power plants or did EPA look at what the costs are projected to be when CCS reaches the status of a fully mature technology?

- a. What are the differences in cost between CCS in its current status and when it reaches status as a fully mature technology?
- b. Has the Department of Energy shared with EPA how long before CCS is considered a fully mature technology and cost competitive for power plants?
- c. Mr. Julio Friedmann, Deputy Assistant Secretary at the Department of Energy is an expert in CCS technologies. He recently testified that early stage deployment of CCS for new power plants would increase the costs of wholesale electricity by approximately "70 to 80 percent." Does EPA dispute the validity of this statement?

Answer: For an emerging technology like CCS, costs can be estimated for a "first-of-a-kind" (FOAK) plant or an "nth-of-a-kind" (NOAK) plant, the latter of which has lower costs thanks to the "learning by doing" and risk reduction benefits that result from serial deployments as well as from continuing research, development, and demonstration projects.

For plants that utilize technologies that are not yet fully mature and/or which have not yet been serially deployed in a commercial context, such as IGCC or any plant that includes CO₂ capture, the cost estimates in Table 6 of the proposal preamble represent a plant that is somewhere between FOAK and NOAK, sometimes referred to as "next-of-a-kind," or "next commercial offering." These cost estimates for next commercial offerings do not include the unique cost premiums associated with FOAK plants that must demonstrate emerging technologies and iteratively improve upon initial plant designs. However, these costs do utilize currently available cost bases for emerging technologies with associated process contingencies applied at the appropriate subsystem levels.

The predicted costs for deployment of CCS can vary depending on a variety of reasons. We do not know the assumptions that went into Mr. Friedmann's estimated costs. However, we note in the proposed standards of performance that deployment of "partial CCS" – rather than "full CCS" (i.e., at capture levels of 90 percent or greater) – can be done at a much lower cost. In Table 6 of the proposed standards, we provided cost estimates for new generating technologies meeting the proposed emission limit. The increased cost ranged from 12 – 20 percent. Those costs can be further lowered when the new plant is able to sell the captured CO₂ for use in enhanced oil recovery (EOR) operations.

Because the proposed new source carbon pollution standards are in line with current industry investment patterns, they would not have notable costs and are not projected to impact electricity prices or reliability. The incremental prices cited by DOE may be applicable to a specific plant relative to another specific plant. However, one hypothetical plant does not significantly change retail prices paid by consumers, which are derived based on the cost of generation and transmission across the power system.

Question 37: In the proposed New Source Performance Standard rule for new electricity plants, EPA states that the standard it set for a new natural gas combined cycle power plant (1,000 pounds of CO₂ per megawatt hour) is being met by over 90% of those types of plants in operation today. How many coal fired power plants in operation today can meet the proposed standard (1,100 pounds of CO₂ per megawatt hour) for new coal power plants?

Answer: There are no coal-fired facilities operating today that are required to meet a standard of 1,100 lb/MWh. However, both the Boundary Dam plant and the Kemper IGCC plant are both in advanced stages of construction and are both designed to emit CO₂ at levels significantly lower than 1,100 lb CO₂/MWh proposed standard.

Question 38: In previous EPA testimony, the Agency says the proposed standards for a new coal power plant "reflect the demonstrated performance of efficient, low carbon technologies that are currently being used today."

- a. Are there any full-scale coal power plants currently operating in the US that are using fully integrated CCS technology?
- b. Are there any electricity generating plants using CCS components in a FULLY INTEGRATED system (not gasification or EOR systems)?
- c. If not, how can EPA select a standard without knowing whether it is achievable in practice?

Answer: EPA's proposed standards rely on a wide range of data, information, and experience well beyond that generated by particular projects. The EPA has determined that CCS is technically feasible for new coal-fired power plants because all of the major components of CCS – the capture, the transport, and the injection and storage – have been demonstrated and are currently in use at commercial scale.

Topic: Social Cost of Carbon

Question 39: How many EPA full-time equivalent (FTE) hours were dedicated to the Interagency Working Group that developed the 2013 social cost of carbon estimates?

Answer: EPA employs staff with expertise in science and economics who work on issues related to climate change and contribute to the development of good science and sound policy. In that capacity, EPA staff from the Office of Policy (OP) and Office of Air and Radiation (OAR) provided technical expertise to the broader SCC workgroup as needed. The nature of such work and interactions with EPA's broader climate portfolio does not allow for Agency resource estimates at the fine resolution level requested.

Question 40: How much (in dollar amount) of EPA's FY 2014 appropriations were dedicated to the Interagency Working Group's 2013 social cost of carbon estimates, including the Office of Air and Radiation's Office of Atmospheric Program's "technical work and the modeling" for the estimates?

Answer: EPA's contributions to the 2013 SCC estimates were funded through the budget allocations to OP and OAR, specifically through salaries that covered staff time. As noted above, the nature of such work and interactions with other projects does not allow for precise Agency resource estimates at the fine resolution level requested.

Question 41: Do you believe it is appropriate for the EPA to enter into formal consultation with USFWS to assess impacts on threatened and endangered species from major regulations under the Clean Air Act? As you are aware, EPA consults with the USFWS under the 316(b) cooling water intake rule, so why not allow such consultation for greenhouse gas regulations that could have land use impacts with far greater consequence?

- a. Do you disagree with the Director Ashe of US Fish and Wildlife Service, who said you are obligated to consult with USFWS?
- b. What arguments have you given to Director Ashe as to why you are not obligated to do so?

Answer: The EPA's proposed new source performance standards for emissions of greenhouse gases from new fossil fuel-fired power plants was published in the *Federal Register* on January 8, 2014, and the comment period closed May 9, 2014. Any final rule the agency issues will be science-based, be legally sound, and clearly explain the agency's compliance with the Endangered Species Act while also addressing any comments we receive on that issue.

Topic: EPA's TSCA Budget

Question 42: The President's FY 2015 Budget justification indicates that the Agency will realign \$23 million to focus on several priorities, including implementation of the President's Executive Order on Chemical Safety (E.O. 13650). In a reference to the realignment of funds to address air toxics work, EPA stated the following:

In the agency's chemical safety program, realignments will be used to develop and release 19 draft chemical risk assessments and complete 10 final chemical risk assessments. These actions are critical in achieving the agency's long-term chemical safety goals.

Are the chemical risk assessments referred to in the Budget proposal the same assessments yet to be completed under the Work Plan Chemical program?

Answer: Yes, the 29 chemicals referenced in the question are associated with the TSCA Work Plan chemicals.

Question 43: I believe EPA has completed five draft chemical assessments under the Work Plan Chemical program to date.

- a: When will the first five assessments be made final?

Answer a: EPA anticipates making the final risk assessments available this calendar year.

b: Do you agree that the Work Plan assessments are a possible model for the Agency's work under a reformed Toxic Substances Control Act?

Answer b: The development of risk and other assessments for TSCA Work Plan Chemicals is consistent with the administration's principles to update and strengthen TSCA. These include that chemicals should be assessed against a risk based safety standard and that EPA should have authority to set priorities for conducting safety reviews on existing chemicals based on relevant risk and exposure considerations.

c: The Agency reviewed some 1,200 chemicals in prioritizing 83 substances for the Work Plan Chemicals program. Is it your opinion that the Agency has the expertise and capability to prioritize substances in commerce, for further review and assessment, relatively quickly and efficiently?

Answer c: Prioritization for the Work Plan chemicals process focused on identifying chemicals which are a high priority for risk assessment. The TSCA Work Plan chemicals were identified following a screening process that was developed after consultation with stakeholders on the criteria and data sources to be used for identifying chemicals for assessment. However, many chemicals could not be screened because useful hazard and/or exposure information on them is lacking.

d: The Work Plan Chemical assessments are intended to identify where additional regulation might be necessary with respect to a particular substance. In the first five draft Work Plan chemical assessments, have any additional regulatory needs been identified?

e: How does the Agency intend to address those identified needs – what regulatory measures will the Agency take on those substances?

Answer d and e: Regulatory actions are based on two distinct elements: risk assessment and risk management. The first five TSCA Work Plan Chemical assessments are risk assessments intended to identify whether there are risks associated with chemical(s) for specific exposure scenarios. A risk assessment does not encompass risk management actions such as regulatory development; rather, its purpose is to inform risk managers about what risk management actions, regulatory or otherwise, may be needed.

The EPA is currently assessing public and peer review comments on the initial draft risk assessments released in FY 2013. EPA will consider the findings contained in those final risk assessments as well as other inputs to determine if risk reduction activities are needed to address potential concerns. This could involve regulatory options, non-regulatory options, or a combination. Again, as noted in the first response, EPA anticipates making the final risk assessments and response to comments documents available this calendar year.

Question 44: The FY 2015 Budget proposal includes funding for implementing EPA's various chemical and pesticide safety programs under a broad category called "Ensuring the Safety of Chemicals and Preventing Pollution Prevention." The Agency proposes an increase of \$42.5 million for that category for FY 2015, with \$40.3 million of that increase targeted at chemical safety programs. I'd like to have a better understanding of what that \$40 million increase will be used for.

a: Under the FY 14 budget, the Agency's TSCA program was budgeted at \$62.7 million, split between \$48 million for existing chemicals management and \$14 million for new chemicals. So the FY 15 budget suggests no increase for management of the Toxic Substances Control Act over FY 2014. Is that correct?

Answer a: No. The FY 2015 President's Budget proposes \$62.7 million for the Chemical Risk Review and Reduction (CRRR) Program, under which the majority of TSCA implementation work is funded. This is an increase of \$4.1 million over the FY 2014 Enacted Operating Plan levels of \$58.6 million. The \$62.7 million request is split between \$17.1 million for New Chemicals and \$45.6 million for Existing Chemicals.

b: Since the \$40 million increase is not going to TSCA implementation, what will the funding increase support?

Answer b: The proposed \$42.5 million increase is for the entirety of Goal 4, "Ensuring the Safety of Chemicals and Preventing Prevention," which encompasses many programs across the Agency, including chemical and pesticide safety, children's health, research and development, and homeland security. Within the \$42.5 million, \$4.1 million is for the Chemical Risk Review and Reduction Program, details for which are provided in the response to the prior question.

c: The FY 14 Budget justification indicated that implementation of all of the Agency's existing TSCA authorities were a priority objective. Do you agree that TSCA implementation continues to be a priority for EPA?

Answer c: Yes, EPA continues to consider chemical safety one of the Administrator's top priorities and one of her seven themes (Taking Action on Toxics and Chemical Safety). TSCA implementation is, in particular, a key priority and EPA strives to carry out all of its responsibilities under TSCA within the limits of existing statutory authority and available resources.

d: Can you outline for me what the Agency accomplished in FY 14 in fully implementing its existing TSCA authority?

Answer d: FY 2013 accomplishments are highlighted in the FY 2013 Annual Performance Report, which is included in the FY 2015 President's Budget as an appendix. The FY 2014 Annual Performance Report will be released as a part of the FY 2016 President's Budget in February 2015.

In 2014, EPA is

- Addressing TSCA Work Plan chemicals, conducting risk management activities (e.g. Significant New Use Rules), and developing the final formaldehyde rules.
- Reviewing, and, as appropriate, making regulatory decisions on new chemicals, typically around 1,000 a year.
- Finalizing e-reporting rules and guidance, including issuing final eTSCA rule in FY 2014.
- Expanding public access to chemical and health and safety data, including populating and expanding ChemView, a recently launched database that provides streamlined access to an array of TSCA chemical information.

Question 45: The FY15 Budget justification indicates that there are more than 22,000 CBI claims in health and safety studies as of 2010. Since that time, the Agency has been working to address those claims in the CBI Challenge Program, in which you challenged companies to review and address their claims.

a: Does EPA still contend there were 22,000 CBI claims in health and safety studies now?

Answer a: In 2010, the Agency identified a universe of 22,483 TSCA Section 4, 5, and 8 cases which may have claims for CBI for the chemical identity in the health and safety studies. Through the process of review, the Agency has determined that CBI claims had been made in all these cases, but in many instances, the submissions did not contain health and safety studies.

b: Since the Challenge program was begun, some 16,291 cases were reviewed. Is that correct?

Answer b: Yes, as of March 31, 2013. As reported in EPA's Annual Performance Report for FY 2013, as of September 30, 2013, 17,617 cases had been reviewed.

c: Of those 16,291 cases, 12,043 had no CBI at all. Is that correct?

Answer c: No. The 12,043 cases reviewed is a reference to the subset of the 17,617 cases reviewed through FY 2013 that are largely associated with TSCA section 5 filings, which while they did contain CBI, they did not include health and safety studies with chemical identity claimed as CBI.

d: Would you agree that EPA wrongly classified some CBI claims when in fact there were not CBI claims made? In other words, didn't the 22,000 figure erroneously cite the number of CBI claims made with respect to health and safety studies?

Answer d: No. As explained above, the figure 22,000 (more precisely, 22,483) represents the total number of CBI cases included in the universe of cases initially identified for review. The Agency originally identified these cases as potentially containing CBI claims

for the chemical identity in the health and safety studies. Through the review process for the 17,617 cases to date, EPA determined that all those cases did contain CBI claims. However, in many of those cases, the claims were not for the chemical identity in the health and safety studies.

e: What was the cause of this significant error?

Answer e: To date, all of the cases reviewed contain CBI claims. The older tracking systems from the late 1970s flagged the presence of CBI claims but did not differentiate data types. For this reason, the Agency has stated, on its website and other public forums, that the cases “may have” CBI claims specifically linked to chemical identity and health and safety studies. These cases were not erroneously classified.

f: Would you agree that the perception that industry made excessive CBI claims is in error, and not borne out by the facts?

Answer f: All of the 17,617 cases reviewed through FY 2013 did contain CBI claims.

g: I understand that of the roughly 10,000 cases that in fact had CBI claims, some 3,349 were allowed, 909 have been declassified, and about 7,200 remain to be reviewed. Is that correct?

Answer g: The total number of filings to be reviewed for FY14 is 4,866. The 7,200 number referred to is from March, 2013. By the end of the fiscal year, EPA had increased its reviews to a total of 3,003, bringing the total number of to be initiated reviews down to 4,866 for FY14.

Regarding the 3,003 reviewed filings, in most instances, the filings did not meet the Agency criteria for declassification because the confidential business information (CBI) claims related:

- (1) to filings on chemicals or mixtures not actually in commerce, because of chemical identity issues, it was impossible to ascertain inventory status or were filings on non-TSCA uses,
- (2) the claims did not relate to health and safety data elements, or
- (3) the CBI claims for chemical name were valid under the implementing regulations.

The Agency was able to secure the declassification of 316 filings in FY13.

h: Would you consider the CBI Challenge program a success? What is the Agency doing to make clear that there was a significant error in the number of reported CBI claims, and to more closely track the actual number of claims made?

Answer h: As explained above, there was no significant error in the number of reported CBI claims. Yes, we would consider the program a success for several reasons. First, the program

is directly responsible for the release and public posting, to date, of 1,000 health and safety studies, previously not publicly available, on chemicals. These are largely voluntary declassifications by industry. Second, the program is responsible as well for the posting to the public portion of the TSCA Inventory of the identities of more than 600 chemicals previously treated as confidential. Third, the program has enabled more effective outreach to the regulated community clarifying the statutorily prescribed rules on what can and what cannot be claimed as confidential. The resulting dialogue has resulted in savings for both industry and the Agency.

Topic: Hydraulic Fracturing

Question 46: I am very concerned that the hydraulic fracturing study that EPA has been working on for over four years has gone beyond Congressional intent and has inappropriately expanded in scope. The request to EPA in the FY 2010 appropriations report was for EPA to study any link between hydraulic fracturing and drinking water. Yet four years later, despite serious concerns about how EPA is conducting this study, I understand the agency is now embarking on several new research areas and may have 30 or more separate reports steaming from this study. The agency seems to be studying every water issue related to oil and gas development.

a: What justification does the Agency have for going well beyond the Congressionally mandated scope?

Answer a: The scope of the EPA's *Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources* is responsive to Congress' original request and was supported by the agency's Science Advisory Board in their review of the draft Study Plan in 2011. There has been no expansion of the scope beyond the original appropriations language.

b: What is the current timeline to issue the study?

Answer b: The *Study of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources* is national in scope and very complex. The careful and intensive review and synthesis of literature, research results, and stakeholder input, along with the recently intensified state outreach effort, will ensure that EPA's draft science assessment is as robust and complete as possible. We expect to release the draft assessment report for public comment and peer review by early 2015. The EPA then expects to provide a final report that is responsive to comments received from the public and the peer review.

c: What are current total EPA costs to date of this study?

d: What do you expect to be the total costs of the study once it is completed?

Answer c and d: Below is a table of funding for the study for each fiscal year:

FY 2010 Enacted	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Enacted	FY 2014 Enacted	FY 2015 Pres Bud
\$1.9M	\$4.3M	\$6.1M	\$6.1M	\$6.1M	\$6.1M

Please see table above. The current costs of the study through FY 2015 total \$30.6 million. EPA has not yet developed its FY 2016 budget request.

e: What is the status of EPA's prospective case studies?

Answer e: We have worked closely with industry partners to try to identify suitable locations for prospective case studies that meet the scientific needs of the study and industry's business needs. Unfortunately, so far, we have not identified a suitable location. For a location to be suitable, it is necessary to gather a minimum of one year of characterization data for ground water and surface water prior to and following unconventional exploration activities in the study area, and for there to be no other hydraulic fracturing activities on adjacent properties, currently or potentially leased, during the entire study period, which could last several years.

Question 47: I am also concerned that this study will be released publicly before there is a peer review by the Science Advisory Board. It is my understanding that EPA plans to release the study to the public at the same time it is submitted for peer review, which is unacceptable and similar to the Agency's actions in their less than credible Pavillion, Wyoming investigation.

a. Isn't this poor process setting the Agency up again for a situation in which EPA may have to back track on findings after the initial draft is peer reviewed?

Answer a: The EPA customarily makes a draft report available for comment at the same time it is submitted for peer review by the Science Advisory Board (SAB). With reference to Highly Influential Scientific Assessments, Section III(5) of OMB's *Final Information Quality Bulletin for Peer Review* states that: "Whenever feasible and appropriate, the agency shall make the draft scientific assessment available to the public for comment at the same time it is submitted for peer review (or during the peer review process)."

b: This type of timeline has been used successfully by the EPA to scare and mislead the public with draft findings which are later debunked or never peer reviewed at all. Isn't this sort of timetable and procedure contrary to the goals of releasing a credible study or one that meets HISA requirements?

Answer b: OMB's *Final Information Quality Bulletin for Peer Review* stresses the importance of public comments in shaping expert peer review deliberations; therefore, the EPA customarily makes a draft report available for comment at the same time it is submitted for peer review by the Science Advisory Board (SAB). Before sharing the draft assessment report with the SAB and the public, the findings from the individual research projects contained in the report will

have undergone both an internal peer review and independent, external peer review (with the exception of Confidential Business Information, whose release is restricted). Additionally, the data themselves will have undergone rigorous quality assurance checks prior to the external peer review.

- c:** Given the struggles of EPA's previous investigations into hydraulic fracturing and the Agencies severely damaged credibility in this arena, how are you planning on ensuring the scientific validity of this current study?

Answer c: Quality assurance is the procedure used to assure that valid data are generated and used in a study. The data being used in the study have undergone rigorous quality assurance procedures prior to their use in developing research reports and papers and prior to peer review of the reports or papers. Then, peer review ensures that the methodology for data analysis and conclusions drawn from the data are scientifically sound and well founded.

- d:** How is EPA planning on ensuring that any and all information disseminated to the public as a possible conclusion is properly vetted and peer reviewed if it is releasing conclusions prior to review by the SAB?

Answer d: See answers above. When an agency releases information for the purposes of peer review, it is not considered an official "dissemination" of information to the public. This is made clear by adding a disclaimer notifying the reader that the draft document is being distributed for pre-dissemination peer review and does not represent Agency policy.

Question 48: The Agency has indicated that they will not do a risk assessment to put all this information into some actual context.

- a.** Why does EPA refuse to conduct a risk assessment as part of the study?

Answer a: Consistent with the scope defined by Congress in its request, EPA's report will provide an assessment of the potential for hydraulic fracturing activities to change the quality or quantity of drinking water resources in the United States. This report will identify factors affecting the frequency and severity of impacts. EPA's report will represent a state of the science synthesis of information concerning the subject and will be national in scope. Consistent with the scope prescribed by Congress' request, we did not conduct site-specific or national predictive modeling to quantitatively estimate environmental concentrations of contaminants in drinking water resources. The report will not be a human health exposure assessment, will not identify populations at risk, nor estimate human health impacts.

- b:** Does the Agency plan on putting any of the study's findings or conclusions into context? If so, how?

Answer b: Yes. As a state of the science assessment, EPA's report will use information from the scientific literature and government reports, including peer-reviewed publications from research conducted under EPA's *Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*.¹ We are considering material submitted by the public, industry, and regional and state entities in response to EPA's requests for data and information through stakeholder workshops, roundtables, and Federal Register notice. We also have recently intensified our state outreach efforts as part of the study. These efforts will ensure that states understand the data sources we used and will provide them further opportunity to recommend additional sources of information. These robust and diverse information sources provide a solid scientific foundation and context for EPA's report.

Question 49: You've said that hydraulic fracturing can be done safely and have agreed with former EPA Administrator Lisa Jackson that there have been no confirmed cases of hydraulic fracturing impacting drinking water. What is your vision for getting the American public to understand that hydraulic fracturing is safe and that fracking has unlocked an American energy revolution that has lowered all Americans' energy prices, created jobs, helping lower GHG emissions and revitalizing such industries as the manufacturing, steel and chemical sectors?

Answer: EPA is committed to working with states and other stakeholders to understand and address potential concerns with hydraulic fracturing so the public has confidence that unconventional oil and gas production will proceed in a safe and responsible manner. In so doing, we will continue to follow a transparent, science-driven approach, with significant stakeholder involvement.

Question 50: The DOE and USGS have known experience conducting drilling and water sampling studies in the field. Specifically, DOE's NETL is doing a study in PA's Greene and Washington counties to assess the environmental effects of shale gas production and a July 2013 press release issued by NETL stated that "while nothing of concern has been found thus far, the results are far too preliminary to make any firm claims. We expect a final report on the results by the end of the calendar year."

a: Are you aware of this study?

Answer a: Yes, we are aware of this study.

b: Are you asking that DOE share this type of work and can you use this study in the larger EPA water study?

Answer b: EPA looks forward to receiving the reports for NETL's studies in Pennsylvania's Greene and Washington counties when they become final. As appropriate, we will use the results of NETL's study to inform the development of our study of the potential impacts of hydraulic fracturing for oil and gas on drinking water resources. Additionally, both DOE and

USGS are aware of EPA's ongoing study, our continued progress with that study, and our willingness to consider any relevant papers, reports, or materials that may inform the development of our study.

- c:** Specifically, would the EPA benefit from the DOE's and USGS's expertise in these issues as part of the EPA's larger water study which continues to drag along and clearly demonstrates that the EPA's taken on more than it can chew?

Answer c: EPA has been and will continue to engage with our interagency partners in DOE and USGS to improve understanding of the potential impacts of developing our Nation's unconventional oil and gas resources so the public has confidence that unconventional oil and gas production will proceed in a safe and responsible manner. We are exchanging information regarding each agency's research related to hydraulic fracturing and drinking water resources. We appreciate the continuing input of DOE and USGS to help inform our assessment as we all work to capture the state of the science concerning hydraulic fracturing and drinking water resources in the United States. The careful and intensive review and synthesis of literature, research results, and stakeholder input, along with the recently intensified state outreach effort, will ensure that EPA's draft science assessment is as robust and complete as possible.

Question 51: Last June, ORO announced it would abandon its flawed drinking water investigation in Pavillion, WY and would instead support a further investigation by the State of Wyoming.

- a:** Given the flawed science on display by the agency at Pavillion and ORO's withdrawal, will you exclude the agency's work and data prior to June 2013 from the agency's Congressionally-requested study on the relationship between hydraulic fracturing and drinking water? If not, why not?

Answer a: The EPA does not plan to finalize or seek peer review of its draft Pavillion groundwater report released in December 2011 nor does the agency plan to rely upon the conclusions in the draft report.

- b:** ORD abandoned its investigation, yet according to agency statements, continues to "stand behind its work and data." How can the agency reconcile these directly contradictory actions? How would you explain to the American people that continuing a flawed investigation is not worth taxpayer resources, yet the agency "stands behind" the work and data that it abandoned?

Answer b: As you may be aware from our statement at the time of the State of Wyoming's announcement on June 20, 2013, we believe that EPA's focus should be on using our resources to support Wyoming's efforts, which will build on EPA's monitoring results. In light of the State's commitment to further investigation and efforts to provide clean water to Pavillion residents, EPA does not plan to finalize nor seek peer review of its draft report.

Wyoming's continuing investigation seeks to address water quality concerns and will consider sampling data obtained through the EPA's groundwater investigation. Wyoming held a public meeting on June 12, 2014, to report on the status of the progress of the investigations and reports and to introduce the independent expert selected for the domestic well investigation. The state sought EPA and stakeholder input on the selection of the independent expert who will provide advice to the state in the completion of their investigation and reports. Michael Acton of Acton Mickelson Environmental Consultants was selected by the State and introduced at the June 12 meeting as the independent expert for the domestic well study. At the June 12 meeting, the state indicated that it has installed the domestic water loadout facility at the Town of Pavillion, formed a water delivery association, installed 18 cisterns for 16 landowners and expects to install another 13 cisterns for 12 landowners by late fall. Also, at the June 12 meeting, the state indicated that it expects to deliver the draft final well bore integrity evaluation report to EPA and Encana mid-July to early August and anticipates delivery to EPA and Encana of the draft surface pits review report sometime between end of July to early August. On July 24, 2014, the state provided notice that the Well Bore Integrity draft report would be issued to the public at the same time this draft report is released to Encana and EPA. The state issued this Well Integrity Review report on August 5, 2014, and is requesting public comment by September 6, 2014.

Question 52: In February the EPA's IG sent a memo to the EPA Office of Water outlining an initiative the IG has underway that will "determine and evaluate what regulatory authority is available to the EPA and states, identify potential threats to water resources from hydraulic fracturing, and evaluate the EPA's and states' responses to them." Do you consider this a duplication of the EPA's efforts as it relates to the multi-year and multi-million dollar hydraulic fracturing and water study currently in process at the EPA and if not, then how do these studies differ? Hasn't EPA independently done this type of evaluation?

Answer: The OIG does not consider its evaluation in this case as duplicative of the study by the EPA's Office of Research and Development (ORD). ORD's Final Study Plan is scoped to the hydraulic fracturing water lifecycle, defined by ORD to include water acquisition, chemical mixing, injection, flowback and produced waters, and wastewater treatment. The OIG will not undertake a review of these matters. The OIG is not conducting independent scientific evaluations, laboratory studies or toxicological studies as planned in ORD's study.

Topic: Water Connectivity Study:

Question 53: EPA recently released a notice of proposed rulemaking that would constitute the greatest expansion of federal control over land and water resources in the 42-year history of the Clean Water Act (CWA). The "Kennedy test" in the *Rapanos* Supreme Court decision calls for the finding of a "significant nexus" between waters for the assertion of federal jurisdiction. The EPA Office of Water asked the Office of Research and Development to conduct a Connectivity Study to help inform the Agency's regulatory policy decisions. If EPA intended for the science to inform policy decisions, the regulatory process should not have been initiated until the

Connectivity Study was completed, along with a robust peer review of the study. That did not happen. In addition, the Connectivity Study is fundamentally flawed since there was no definitional finding of what constitutes a "significant" connection.

- a. Do you believe it is important that the "waters of the United States" regulation be based on sound science? If so, how can you justify moving forward with the expansion of the scope of "waters of the United States" before the Connectivity Study is completed and has undergone peer review?

Answer: We agree that it is essential for the Agency's regulatory promulgation to reflect the most current relevant science. In the case of the proposed rulemaking for the definition of "waters of the U.S." under the Clean Water Act (CWA), the EPA's Draft Connectivity Report ("Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence") provides a review and synthesis of over 1,000 pieces of published, peer-reviewed scientific literature regarding the effects that streams, wetlands, and open waters have on larger downstream waters such as rivers, lakes, estuaries, and oceans. The draft report does not reflect new information or new science. The draft report already has undergone both internal and independent external peer review, and is now being reviewed by the EPA's independent Science Advisory Board (SAB). The peer review report from the first peer review is available on the docket for the proposed rule, and the draft Connectivity Report reflects comments from that first peer review. The SAB published its draft peer review on April 1 and held public teleconferences to discuss the draft review on April 28 and May 2. The SAB expects to issue a final peer review report later in 2014. The EPA has committed that the rule will not be finalized until the SAB review and the final Connectivity Report are complete.

Topic: Economic Impacts

Question 54: In performing the cost-benefit analysis required for development of the proposed regulation, why did you choose to use the permitting numbers from 2010 as your baseline? As you know, due to the economic recession occurring at the time, there were scarcely any construction activities initiated during that year and the numbers were deflated. In addition, why did EPA only examine the cost impacts under Section 404 and not for other CWA programs?

Answer: At the time the economic analysis was developed, 2010 permit data was the most current information available. The cost estimate in the economic analysis was based on 2010 dollars, and all cost and benefit information was adjusted accordingly. The EPA analyzed the proposed rule's expected impact to each program under the Clean Water Act. The methodology and findings are documented in "Economic Analysis of Proposed Revised Definition of Waters of the United States," March 2014, which is in the docket for the proposed Waters of the U.S. rule. The agency invites comments on this document as part of the public comment period on the proposed rule and will update the analysis to support the final rule.

Question 55: The economic analysis completed by the agency predicts that only 2.7% more waters will be made federally jurisdictional by the proposed "Waters of the United States" rule. As you know, the analysis - including the 2.7% figure - has been severely criticized by credible economists and is likely to be underestimating the potential impact of the rule. Given the outstanding concerns with the analysis, can you explain why the agency did not wait to go forward with a proposed rule until the agency had addressed these concerns and produced a credible economic analysis to inform the public?

Answer: The economic analysis actually uses a figure of 3.2 percent for the additional waters that would be considered protected by the Clean Water Act (CWA). This figure reflects that a small percentage of non-adjacent "other waters" would be found to have a significant nexus and be subject to CWA jurisdiction under the proposed rule. The 2.7 percent number cited in this question came from the economic analysis for the 2011 draft guidance, which is now superseded by the economic analysis prepared for the proposed rule. We are committed to an inclusive, transparent, review and comment process, ensuring that all interested parties have ample opportunity for input and information for our consideration. The EPA and the U.S. Army Corps of Engineers (Corps) published the proposed rule for public comment on April 21, 2014, with a 91-day public comment period extending to July 21, 2014. That public notice included the agencies' economic analysis, which also is available for the first time for public review and comment. We will address these comments and questions and include them in the official docket, Docket Id. EPA-HQ-OW-2011-0880 at <http://www.regulations.gov>. The EPA and the Corps will carefully consider these comments in deciding what changes to make to the final rule.

Question 56: David Sunding, Ph.D., recently reviewed EPA's economic analysis associated with the proposed "Waters of the United States" rule and concluded that the errors and omissions in EPA's study are incredibly severe and may render it essentially meaningless. To address these issues, Dr. Sunding recommended that the agency withdraw the economic analysis and prepare an adequate study for this major change in the implementation of the CWA. Would you be willing to withdraw this flawed economic analysis and develop a new analysis addressing these concerns?

Answer: We are committed to an inclusive, transparent, review and comment process, ensuring that all interested parties have ample opportunity to submit information for our consideration. The EPA and the U.S. Army Corps of Engineers (Corps) published the proposed rule for public comment on April 21, 2014, with a 91-day public comment period extending to July 21, 2014. That public notice included the agencies' economic analysis, which also is available for the first time for public review and comment. Dr. Sunding has not yet shared his specific comments with the EPA nor the Corps, and has the opportunity to do so during the comment period. We will address these comments and questions and include them in the official docket, Docket Id. EPA-HQ-OW-2011-0880 at <http://www.regulations.gov>. The EPA and the Corps will carefully consider these comments in deciding what changes to make to the final rule and accompanying economic analysis.

Question 57: I understand that when assessing the potential economic costs and benefits of EPA's proposed "waters of the United States" rule, the agency omitted analysis of certain key programs that will undoubtedly be impacted by the rule. The agency provides no analysis for costs related to: the development of state water quality standards, monitoring and assessment of water quality, total maximum daily load development, and the entire industrial wastewater NPDES permitting program. In addition, EPA based its abbreviated assessment of impacts on the 311 spill program on "anecdotal" evidence. Can you explain why the EPA omitted or provided very little analysis of these key programs?

Answer: The EPA analyzed the impact to each program under the Clean Water Act. This information is documented in "Economic Analysis of Proposed Revised Definition of Waters of the United States," March 2014, which is in the docket for the proposed Waters of the U.S. rule.

Question 58: The EPA certified that this proposed rule will "not have a significant impact" on small businesses and communities. However, the agency did not gather significant feedback from those impacted prior to the rule being proposed. According to the U.S. Chamber of Commerce, it takes up to 12 months and costs hundreds of thousands of dollars to obtain a wetlands permit. Are you able to assure this committee that the costs and timelines associated with permit reviews will not be extended by this change in jurisdictional definition?

Answer: Under the Regulatory Flexibility Act (RFA), agencies certify whether or not the rule will have a "significant economic impact on a substantial number of small entities." The scope of regulatory jurisdiction in this proposed rule is narrower than under existing regulations. Because fewer waters will be subject to the CWA under the proposed rule than are subject to regulation under the existing regulations, this action will not affect small entities to a greater degree than the existing regulations. As a consequence, this action, if promulgated, will not have a significant economic impact on a substantial number of small entities.

In addition, the agencies sought early and wide input from small businesses while developing the proposed rule. On October 12, 2011, the EPA held an all-day meeting with representatives from small businesses, small government entities, and small nongovernmental organizations, to discuss their perspectives on CWA jurisdictional scope. Attendees also submitted written comments following the meeting. Between fall 2011 and fall 2012, EPA held a series of meetings with local and city governments, including small governments. Small entity input from meetings and written comments have helped inform the draft proposal.

Question 59: The cost benefit analysis supporting the "waters of the United States" proposal contains numerous deficiencies. According to the National Stone, Sand, and Gravel Association the increased mitigation costs for just one site can be \$100,000 or more under the new rule. With over 10,000 of these facilities in the U.S. and dozens of industries affected, the costs of this rule have been drastically underestimated. While these deficiencies have been pointed out to EPA and the Corps, the very low estimates are still repeated by EPA and Corps officials. Does the EPA have plans to revise the cost benefit study to address these legitimate concerns?

Answer: We are committed to an inclusive, transparent, review and comment process, ensuring that all interested parties have ample opportunity for input and information for our consideration. The EPA and the U.S. Army Corps of Engineers (Corps) published the proposed rule for public comment on April 21, 2014, with a 91-day public comment period extending to July 21, 2014. We will address these comments and questions and include them in the official docket, Docket Id. EPA-HQ-OW-2011-0880 at <http://www.regulations.gov>. The EPA and the Corps will carefully consider these comments in deciding what changes to make to the final rule and accompanying economic analysis.

Question 60: As you know, there are several new definitions and concepts contained in the proposed "Waters of the United States" rule. As a result, there is a distinct possibility that agencies will have to spend more money determining how to actually implement this rule. There also is a strong likelihood that other agencies' programs will be impacted given the broad scope of this proposed rule.

a: Has EPA consulted with other federal agencies that have administrative responsibilities under the Clean Water Act?

Answer a: Yes. The proposed rule was developed jointly with the U.S. Army Corps of Engineers, which is the principal regulator for the Section 404 program. The EPA also had discussions with other federal agencies during the interagency review process which ran from September 2013 through March 2014.

b: Has EPA considered the costs that the EPA and the Corps will incur, without considering other actors, in determining how this rule will be implemented?

Answer b: Yes. The economic analysis analyzes the proposed rule's expected impact to each program under the Clean Water Act, including the costs to the implementing agencies.

c: Does EPA know how other agencies will interpret this rule and whether other agencies will require additional resources in order to understand how their ability to administer their own programs might be affected?

Answer c: Yes. In accordance with Executive Order 12866, the proposed rule was subject to interagency review. The EPA and the Corps of Engineers had discussions with agencies on how the rule might affect their programs. However, these discussions did not identify a need for additional resources for these agencies.

Topic: Clean Water Act Permitting

Question 61: In light of EPA's recent actions concerning Pebble Mine and Spruce Mine, the regulated community is understandably concerned about the lack of certainty currently

surrounding the Section 404 permitting process. How does EPA intend to address these concerns and ensure that the regulated community can have their projects fairly considered and can rely on their permits once they are issued? Would you agree that finality is an important consideration for permits?

Answer: The EPA takes very seriously the authority provided to the agency by Congress, pursuant to Section 404(c) of the Clean Water Act (CWA), to determine whether discharges of dredged or fill material into a specified site in waters of the U.S. would result in an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas.

The EPA's careful use of this authority is indicated by the fact that the agency has completed just 13 Final Determinations since 1972 pursuant to CWA Section 404(c). To put this in perspective, over the same period of time, the Corps of Engineers is estimated to have authorized more than two million activities in waters of the U.S. under the CWA Section 404 regulatory program.

As these numbers demonstrate, the EPA has worked successfully with the Corps and permit applicants to resolve concerns without exercising its Section 404(c) authority in all but a miniscule fraction of cases.

Question 62: According to EPA, the agency initiated the Bristol Bay Watershed Assessment in response to a petition for EPA to exercise its CWA Section 404(c) authority. Has the agency received any other similar petitions, and if so, what has been requested? Has the agency received any petitions concerning the agency's use of Section 404(c) on any existing permits?

Answer: No, to both questions.

Question 63: Does EPA have any plans to potentially perform studies on or initiate the 404(c) process on any other waters at this time? If so, where?

Answer: No.

Question 64: Does EPA have any plans to potentially reevaluate any existing Section 404 permits pursuant to its claimed Section 404(c) authority? If so, which ones?

Answer: No, the agency does not have any such plans.

Question 65: Has the EPA evaluated the consequence of its actions with respect to Bristol Bay and Spruce Mine and the impact the uncertainty will have on investment in natural resource development?

Answer: The restrained and judicious use of EPA's Section 404(c) authority has provided the business community with a high level of investment certainty while also ensuring protection of the nation's most valuable and vulnerable water resources.

Question 66: Could regulatory uncertainty over Section 404 permits drive away investment at the cost of American jobs? Has the EPA studied this issue?

Answer: The EPA takes very seriously the authority provided to the agency by Congress, pursuant to Section 404(c) of the Clean Water Act (CWA), to determine whether discharges of dredged or fill material into a specified site in waters of the U.S. would result in an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas.

The EPA's careful use of this authority is indicated by the fact that the agency has completed just 13 Final Determinations since 1972 pursuant to CWA Section 404(c). To put this in perspective, over the same period of time, the Corps of Engineers is estimated to have authorized more than two million activities in waters of the U.S. under the CWA Section 404 regulatory program.

As these numbers demonstrate, the EPA has worked successfully with the Corps and permit applicants to resolve concerns without exercising its Section 404(c) authority in all but a miniscule fraction of cases. Given the very few instances where the EPA has invoked its Section 404(c) authority, the EPA has not studied the effect of using this authority on investment or jobs.

Question 67: Many states have primacy over their Surface Mining Control and Reclamation Act (SMCRA) permitting programs, and as such, many states expend a great deal of time and resources in the mine permitting process. What effect would a lack of finality in CWA Section 404 permits have on state SMCRA permitting scheme?

Answer: The EPA has taken final action pursuant to its Clean Water Act (CWA) Section 404(c) authority with respect to a surface coal mining project only once (in 2011) in the more than 40-year history of the CWA. As such, the EPA does not believe that the agency's single and judicious use of its authority has meaningfully disrupted other agencies' authorities under the Surface Mining Control and Reclamation Act (SMCRA). It also is important to note that SMCRA and the CWA are separate statutes, each with independent authorities and responsibilities.

Question 68: The President, in executive orders and public statements, has said that streamlining the permitting process for energy projects - particularly those necessary to support renewable energy projects - is a high priority for his Administration. As you know, individual permits, by definition, take longer to get approved. Due to the proposed rulemaking, it's likely that more individual federal permits will be required, especially for energy projects. Where a federal permit is required, other federal requirements also are imposed (NEPA, potential ESA

consultations, historic preservation review, tribal consultations, and citizen suit enforcement), thus lengthening the processing time. Can you explain how this outcome is consistent with the President's streamlining objective?

Answer: The proposed rule does not alter the Clean Water Act Section 404 permitting process administered by the U.S. Army Corps of Engineers and two authorized states. The proposed rule does not alter the Corps' existing nationwide permits (NWPs) that currently streamline the permitting process for many energy projects, such as NWPs 8, 12, 17, 44, 51, and 52. The proposed rule may require additional permits than under current practice, but will expedite the permit review process in the long-term by clarifying jurisdictional matters that have been time-consuming and cumbersome for field staff and the regulated community for certain waters in light of the 2001 and 2006 Supreme Court cases.

Question 69: While the Administration has committed to streamlining and expediting permitting for major infrastructure projects that advance energy (e.g., Executive Order 13604, Blueprint for a Secure Energy Future), there is some concern that this proposed rulemaking will have the opposite effect. This is because EPA's proposed rule creates new sub-categories of water that could be subject to federal jurisdiction, preempts states' rights to regulate internal waters traditionally regulated only by the states, and creates a cumbersome review process for determining which waters are jurisdictional under the new definition of "Waters of the United States."

a: Can EPA guarantee that this rule will not further delay permitting for energy infrastructure projects?

Answer a: The proposed rule does not alter the Clean Water Act Section 404 permitting process administered by the U.S. Army Corps of Engineers and two authorized states. The proposed rule does not alter the Corps' existing nationwide permits (NWPs) that currently streamline the permitting process for many energy projects, such as NWPs 8, 12, 17, 44, 51, and 52. In general, the agencies believe that the proposed rule will expedite the permit review process in the long-term by clarifying jurisdictional matters that have been time-consuming and cumbersome for field staff and the regulated community for certain waters in light of the 2001 and 2006 Supreme Court cases.

b: Has EPA and the Army Corps considered the Administration's goals for energy development and infrastructure expansion in formulating this rule? If so, is that consideration discussed in the rule or elsewhere? Have the agencies requested comments on how this rule might impede the development of energy projects?

Answer b: The proposed rule does not alter the Clean Water Act Section 404 permitting process administered by the U.S. Army Corps of Engineers and two authorized states, or the Section 402 permitting process administered by 46 states and the EPA. For this reason, the

agencies did not explicitly consider the Administration's goals for energy development and infrastructure expansion in formulating the proposed rule.

The EPA and the Army Corps welcome comments on their proposed rule on this and other issues. We are committed to an inclusive, transparent, review and comment process, ensuring that all interested parties have ample opportunity for input and information for our consideration. The EPA and the U.S. Army Corps of Engineers (Corps) published the proposed rule for public comment on April 21, 2014, and comments may be submitted via the official docket, Docket Id. EPA-HQ-OW-2011-0880 at <http://www.regulations.gov>. The original comment period ended on July 21, but on June 10, the agencies notified stakeholders that the public comment period was being extended to October 20, 2014. The EPA and the Corps will carefully consider comments in deciding what changes to make to the final rule.

- c: In the cost benefits analysis for this rule, do the agencies consider any of the potential negative impacts that this rule could have on energy sector development such as: new delays in permitting projects, more cumbersome consultations between state and federal agencies, and more permits needed for the same projects?

Answer c: Because the proposed rule does not change the Clean Water Act Sections 402 and 404 use of general permits, the EPA found that the proposed rule would not have a significant adverse effect on the supply, distribution, or use of energy. This statement is found in the preamble to the proposed rule in section IV.H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use.

Topic: Fill Material:

Question 70: The current definition of fill material, finalized in May 2002, solidified decades of regulatory practice by unifying the Corps and EPA's prior conflicting definitions so as to be consistent with each other and the structure of the CWA. However, both EPA and the Corps have stated that they are considering revising the definition of fill material. These changes could mean that certain mining-related activities would be deemed illegal, thereby preventing mining companies from operating. The FY 2014 Omnibus appropriations bill included language to prevent the Corps from working on any regulation that would change the definition of fill material.

- a. Has EPA engaged in discussions with the Corps on revising the rule?

Answer a: During past years, the Corps and the EPA have discussed actions for the definition of "fill material" that could provide additional clarity. However, the EPA has no active discussions with the Corps in FY 2014 on revising the agencies' definition of "fill material."

- b: What is EPA's rationale for potentially revisiting the well-established division of the Sections 402 and 404 programs?

Answer b: The EPA has no active discussions with the Corps in FY 2014 on revising the agencies' definition of "fill material."

c. What specific problems is EPA seeking to address by revisiting the definition of fill material, and how exactly is EPA intending to address them?

Answer c: The EPA has no active discussions with the Corps in FY 2014 on revising the agencies' definition of "fill material."

Topic: Chemicals

Question 71: In the EPA's proposed FY 2015 budget, the agency is requesting \$23 million in FY 2015 to support activities under the President's Executive Order on chemical safety, as well as Agency efforts on chemical prioritization, air toxics, radon, and volatile organic compounds in drinking water.

a: Can you provide more specific information on the projects this funding will go towards?

b: Do you agree that we need to improve the Local Emergency Planning Committee (LEPC) program and Emergency Planning & Community Right-To-Know Act (EPCRA) reporting system?

c: Will this funding go towards the development of new technology such as a mobile app version of the CAMEO system and the development of a web-based version of EPCRA Tier II submission to facilitate a more accurate and complete hazardous materials reporting system? Such improvements will allow local first responders to prioritize the hazards they may face at the facility.

Answer: Slightly more than half of the resources, \$11.5 million and 11.5 FTE, will support activities under Executive Order 13650 on Improving Chemical Facility Safety and Security. Specifically, these funds will be used to:

- (1) Provide technical assistance and guidance to State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs) in order to improve communications, risk analysis capabilities, and local emergency planning. This will include developing a new pilot grant program to assist local communities, planners, and responders with developing and implementing local emergency contingency plans;
- (2) Conduct additional outreach and technical assistance with chemical facilities to improve safety and security and to reduce risk of hazardous chemicals to workers and communities. This will include revising the RMP rule in line with recommendations from industry and other stakeholders and developing guidance, advisories, and alerts;
- (3) Enhance the Computer-Aided Management of Emergency Operations (CAMEO)

system to include development of a web-based suite for states and a viewer for mobile devices, which would provide easy accessibility for SERCs and LEPCs as well as develop a web-based version of EPCRA Tier II submission to facilitate a more accurate and complete hazardous materials reporting system.

- (4) Additionally, EPA will work with our Federal partners to identify technical assistance opportunities to improve State and local emergency plans and training; expand training opportunities for federal and state RMP/EPCRA partners; and establish a mechanism for data sharing with other Federal agencies.

Of the remaining resources requested:

- \$5 million and 5.0 FTE will provide additional support to enhance the analytical capabilities required to develop regulations, to continue to progress in developing the National Air Toxics Assessment (NATA), to update methods for estimating area and mobile source emissions, and to update air dispersion modeling based on recent advances in the science.
- \$3 million will accelerate EPA's expansion of the risk-based prioritization effort for application to TSCA chemicals, across toxicological endpoints and exposure scenarios beyond those used with endocrine disruptors. Specifically, these funds would be used to: (1) model and generate exposure data; (2) evaluate background exposure levels and biological relevance of environmental exposures; and (3) translate for fit-for-purpose risk-based prioritization.
- \$2.5 million and 4.0 FTE will advance the agency's efforts to achieve the goal of releasing 19 draft chemical risk assessments for public comment and peer review and complete 10 final risk assessments (cumulatively) by the end of FY 2015. These accomplishments also will support the agency's longer-range strategic planning commitment to address all currently identified TSCA Work Plan Chemicals by FY 2018.
- \$1 million and 2.0 FTE will support increased focus on regulating groups of drinking water contaminants, such as volatile organic compounds (VOCs), resulting in effectively addressing potential collective risks of contaminants generally recognized to be present together and demonstrating a predictable strategy for regulating similar contaminants and/or groups in the future.
- \$500 thousand and 1.5 FTE will be used to update radon risk assessment and cost-benefit analyses and begin work to improve radon data management.

Question 72: In the case of the West Texas fertilizer facility tragedy that occurred on April 17, 2013, it appears that the facility was not compliant with a number of existing regulations and industry standards. Do you agree that had existing regulatory requirements and industry standards been fully implemented by West Fertilizer this tragic accident would not have happened?

Answer: EPA has not determined whether the facilities in West, Texas were compliant with all existing federal and state rules and regulations because investigations into the incident, including an investigation by the U.S. Chemical Safety Board (CSB), remain ongoing.

Question 73: Do you agree that we need to improve the Local Emergency Planning Commission (LEPCs) program and Emergency Planning & Community Right-To-Know Act (EPCRA) reporting system?

- a. What would EPA recommend to improve and enhance education / training / emergency response efforts between chemical facilities and their local LEPC and first responders?

Answers a: EPA is participating with other Federal agencies on a Working Group established by the Presidential Executive Order on *Improving Chemical Facility Safety and Security* (EO 13650) to enhance coordination across all levels of state and local government and enhance outreach and information sharing with the chemical industry, emergency managers, first responders, and other stakeholders.

One of the five key areas addressed under EO 13650, is strengthening community planning and preparedness. The EPA is working to improve LEPC programs by developing guidance materials and on-line training to explain roles, responsibilities and authorities under EPCRA to implement local emergency planning. EPA plans to enhance the Computer-Aided Management of Emergency Operations (CAMEO) system by added web-based applications for mobile devices to improve accessibility to LEPCs and State Emergency Response Commissions (SERCs). EPA also plans to develop a web-based version of EPCRA's Tier II Submit electronic reporting system to support state development of internet reporting tools. The Working Group's status report to the President released on June 6, provides detailed information on Working Group priority actions and sets the path forward for continued implementation and sustained coordination and collaboration to improve the safety and security of chemical facilities. A description of Working Group priority actions can be found at: https://www.osha.gov/chemicalexecutiveorder/EO_Fact_Sheet_060514.pdf.

- b. Do you agree that the main issue related to the West Fertilizer tragedy was a storage issue, not an air release issue?

Answer b: The Chemical Safety Board (CSB) is still investigating the root causes and contributing factors associated with the West Fertilizer tragedy. We will not prejudge the outcome of the investigation as to the "main issue" at West Fertilizer. However, improper storage is an accidental release prevention issue under CAA 112(r). For example, EPA RMP rules are required to "cover storage, as well as operations" pursuant to CAA 112(r)(7)(B)(i). Proper storage practices can prevent accidental releases.

Question 74: The EPA Risk Management Program (RMP) was authorized by Congress in the "Clean Air Act Amendments of 1990" following the Bhopal, India accident in 1984. In previous EPA testimony before Congress, the agency stated that the "goal of the EPA's Risk Management Program is to prevent accidental releases of substances to the air that can cause

serious harm to the public and the environment from short-term exposures, and to mitigate the severity of releases that do occur."

- a. Is this still the goal of the agency?
- b. How does EPA define short-term exposure?
- c. Is this consistent with past EPA interpretations?
- d. Do you agree there are statutory factors the agency needs to consider when adding any hazardous substances to the RMP list? If yes, could you list the factors EPA is required to consider?
- e. Would you agree that a product such as solid fertilizer grade ammonium nitrate was never intended to be part of the EPA RMP program as the focus of the program is to address accidental toxic releases into the air from a hazardous gas or liquid?

Answer: The EPA's Chemical Emergency Preparedness and Prevention Program has responsibility for the national regulatory framework to prevent, prepare for and respond to catastrophic accidental chemical releases at industrial facilities throughout the United States. The goal of the Risk Management Program is to prevent major chemical accidents from causing disasters by establishing a prevention and response program.

For the chemicals currently listed under our rules for the RMP, EPA defines short term exposure in the following ways:

- Toxic chemicals - EPA based its listing decisions on the median lethal airborne concentration or dose of each substance, along with the chemical's volatility. The time frame for lethal effects varies by chemical, but is generally measured as a period of minutes, hours, or days.
- Flammable chemicals - EPA based its listing decisions on the potential for the substance, if released, to form a vapor cloud, explode, and immediately cause serious injuries or damage offsite.

In adding substances to the RMP list, the Clean Air Act requires EPA to consider the following criteria: 1) the severity of any acute adverse health effects associated with accidental releases of the substances; 2) the likelihood of accidental releases of the substances; and 3) the potential magnitude of human exposure to accidental releases of the substances (CAA 112(r)(4)).

EPA does not agree that the inclusion of substances on the RMP list is limited to only hazardous gases or liquids. As provided for under Clean Air Act Section 112(r), the focus of RMP is on substances that pose the greatest risk of causing death, injury, or serious adverse effect on human health or the environment from accidental releases.

Question 75: The U.S. chemical industry is one of the most regulated industries in the world and data shows that the industry is one of the safest. This is due to an existing set of safety and security laws, regulations and voluntary programs. Do you agree that EPA should focus its time and resources on increasing training, outreach and education efforts to the

regulated community in order to help with compliance assistance and focus enforcement on companies with a history of noncompliance?

Answer: EPA is participating with other Federal agencies on a Working Group established by the Presidential Executive Order on *Improving Chemical Facility Safety and Security* (EO 13650) to enhance coordination across all levels of state and local government and enhance outreach and information sharing with the chemical industry, emergency managers, first responders, and other stakeholders. Two of the five key areas addressed under EO 13650, is strengthening community planning and preparedness and enhancing federal operational coordination. As part of this effort, the Working Group implemented a pilot in the New York-New Jersey area to coordinate chemical facility preparedness planning and response activities. One of the greatest benefits from the pilot was the discussion of safety and security issues among all levels of government, the first responder community, and stakeholders. This interaction among pilot participants resulted in better working relationships, greater understanding of agency programs, coordination of work in the field, and sharing of critical information and data.

In addition, EPA provides Risk Management Plan (RMP) training for the regulated community, and conducts frequent outreach and education through a variety of means, including conducting training webinars, making presentations at trade association meetings and national conferences, providing training seminars, publishing written guidance materials available via the internet, operating a call center, and conducting direct facility compliance assistance.

RMP enforcement efforts include an increasing emphasis on the inspection of high-risk facilities, which include facilities with a history of serious accidents, facilities with very large quantities of regulated substances, and facilities with large surrounding populations.

Questions Submitted for the Record by Senator Wicker

Question 1: I was disappointed to see that you are proposing eliminating funding for beach monitoring grants under the BEACH Act. These programs are vital to over 35 coastal communities, including my home state of Mississippi. These funds help support water quality and public notification systems.

What is the EPA's rationale for eliminating funding for the beach monitoring grant program in the 2015 budget request?

Answer: The FY 2015 budget meets the challenges of domestic spending constraints while still fulfilling EPA's mission to protect public health and the environment. The agency is proposing to eliminate certain mature program activities that are well-established, well understood, and where there is the possibility of maintaining some of the human health benefits through implementation at the local level. While beach monitoring continues to be important to protect human health, states and local governments now have the technical expertise and procedures to continue beach monitoring without federal support, as a result of the significant technical guidance and financial support the Beach Program has provided.

Furthermore, I would like to know more about the Clean Water Act and Clean Air Act.

Question 2: What percentage of local communities are currently in compliance with EPA requirements under the Clean Water Act and the Clean Air Act respectively?

Answer: There are a variety of requirements under federal law to protect health and the environment in communities. These requirements include provisions to reduce the discharge of raw sewage and contaminated stormwater into community rivers and residents' basements, requirements to protect the safety of drinking water, and restrictions on the emissions of air pollutants that can cause serious health problems. Some facilities to which these requirements apply are operated by local government entities and some are privately operated. For the purposes of this response, EPA is defining the compliance status of communities by the compliance status of regulated facilities within those communities.

The great majority of the information we have on compliance is self-reported – the facility itself monitors and reports on its compliance with the applicable rules. States and EPA do not have the resources to inspect even the large facilities sufficiently frequently to independently verify compliance. Smaller facilities present an even bigger challenge. In addition, our compliance data is primarily at the facility level, and it is not always easy to tell from the data which facilities are publicly operated and which ones are privately operated.

For our data on facilities with Clean Water Act obligations, it is somewhat easier to distinguish private from publicly operated facilities, and most sewage treatment facilities are

publicly run. We only have reliable data for major water dischargers (which means over 1 million gallons a day discharge); we cannot respond to your question for facilities smaller than that. Our records show that in 2013 there were 4,041 major publicly owned sewage treatment plants. In 2013, twenty-eight percent of these reported significant non-compliance, which are the more serious violations. Mayors across the country are concerned about these levels of violations and the importance of clean water to their residents. This is one of the reasons that we have had a multi-year effort, working with the Conference of Mayors and others, to adopt new more flexible approaches to better plan for protecting clean water, prioritizing the most important problems first, and find cost effective ways to remedy problems, while returning other benefits to the community, as we are doing with innovative green infrastructure approaches. We invite you to learn more about these approaches and the benefits they are creating for local communities in clean water, reduced energy demand and more livable communities at <http://cfpub.epa.gov/npdes/integratedplans.cfm>.

In the Clean Air program our data is less complete. Our records for 2013 indicate that there were 7,104 sources regulated under the Clean Air Act that were owned or operated by a county or municipality. In 2013, approximately 1.3% of these facilities were reported as in High Priority Violation status at some point during the year. For a variety of reasons, that is probably an under estimate of the actual violations. In the air program on-site inspections are an even bigger component of identifying serious violations, and, as with water pollution sources, states and EPA cannot inspect a significant portion of the facilities due to constrained resources. Accordingly, it is difficult to say with any confidence what number of facilities are in compliance. We know that communities across the country are concerned about the safety of the air they breathe, and we work hard with our state partners to identify and address the most serious violations.

Question 3: How many Voluntary Consent Agreements, or other similar judicial device, has the EPA entered into regarding the Clean Water Act and the Clean Air Act?

Answer: It appears that your question is asking about publicly owned facility judicial consent decrees. For publicly owned facilities, our data shows the following:

- During the period 2009 – 2013, EPA concluded 47 judicial consent decrees and 1 judicial order to address Clean Water Act violations at municipalities including Publicly Owned Treatment Works (POTWs), Combined Sewer Systems (CSOs), Sanitary Sewer Overflows (SSOs), and Municipal Separate Storm Sewer Systems (MS4s).
- During the period 2009 – 2013, EPA concluded 10 judicial consent decrees to address Clean Air Act (CAA) violations at county or municipal facilities.

Question 4: What has been the financial impact of those agreements on local communities?

Answer: The biggest part of our agreements with all community operated facilities under the Clean Water Act is generally the expense of undertaking the maintenance, repair and upgrading work that has been too long deferred. Pipes that have cracked or eroded, treatment plants that cannot handle the amount of sewage and contaminated stormwater being sent their way, and facilities that have not had the necessary O&M, are all examples of problems that the community addresses through our agreements. One of the challenges of these agreements is that the people who often bear the expense of the too long deferred maintenance and upgrades are the same people who bear the burden of exposure to raw sewage in local waterways or even their own basements, unsafe drinking water, and air that can aggravate asthma or cardiopulmonary disease, among many other problems.

For this reason, EPA works closely with communities through these agreements to get the most important work for protecting health accomplished in the most cost effective way, and on a schedule that is practical and affordable. The costs vary widely depending on the type of problem and the length of time that it has gone unaddressed.

We have been working with the Conference of Mayors and other groups to create additional flexibility to prioritize projects, consider appropriate length of schedules and other means to ensure that the methods chosen by the local community are affordable and practical, and reduce the financial impact of these agreements. The scope, schedule and cost framework for each agreement is different, and we fully agree with the communities' request that each situation be recognized as unique and treated in a way that is both consistent with the protections of the law and reasonable for the community.

Following up with questions from the hearing regarding EPA's Clean Air section 105 air quality management categorical grant program, I would like to ask the following questions.

Question 5: What is the allocation formula for the State Air Grants based on?

Question 6: When the allocation formula was first implemented, what was the distribution of funds to EPA regions?

Question 7: What are the projected changes in the distribution of funds for EPA regions after the new allocation formula is implemented?

Answers 5, 6, 7: EPA remains committed to beginning to implement the updated section 105 allocation formula in FY 2015. Working with our state and local partners, we will minimize disruption to their ongoing program operations by phasing the new formula in over a reasonable period of time.

To distribute the state air grants, the EPA allocates the section 105 grants to the 10 EPA Regions. Each region then negotiates individual workplans with recipients and awards the grant funding.

In implementing the new formula and assuming level funding, the northeast and northwest areas of the country (EPA Regions 1 and 10) would experience decreases by approximately a quarter and a third respectively in their distribution of resources. The southeast (EPA Region 4) distribution would increase by approximately a quarter. Some areas of the country would see smaller decreases (EPA Regions 5 and 6) while the remaining would see more modest increases (EPA Regions 2, 3, 7, 8, and 9).

To help mitigate the impact of the new allocation formula to state programs, we intend to implement a phased-in approach over a multi-year period beginning in FY 2015. To protect the integrity of ongoing state/local air program operations, we intend to moderate shifts in funding so that no Region would experience a decline of more than 5% of its prior year funding level in any one year.

Note: Since FY 2011, Congressional report language has directed EPA to continue to allocate funds under the old methodology.

EPA Region	FY 2014 Section 105 Direct Award Allocation % by Region	% from Updated Direct Award Allocation by Region	% Change with Implementing Updated Allocation
Region 1	8.55	6.18	-27.72
Region 2	9.43	9.76	3.50
Region 3	11.01	11.57	5.09
Region 4	12.42	15.31	23.27
Region 5	16.70	15.19	-9.04
Region 6	9.86	8.83	-10.45
Region 7	3.74	4.01	7.22
Region 8	5.37	5.77	7.45
Region 9	17.57	19.71	12.18
Region 10	5.35	3.67	-31.40
	100.00	100.00	

Questions for the Record Submitted by Senator Fischer

Question 1: The EPA has issued a number of new regulations regarding emissions from electric generating units. What is the EPA's ultimate goal? Is the EPA trying to force utilities to take coal-fired power plants out of operation?

Answer: The EPA's mission is to protect human health and the environment. The proposed limits on carbon pollution from new and existing power plants are intended to implement the provisions of the Clean Air Act in a way that takes into account costs as appropriate, and the EPA expects that they will result in a continued diverse fuel mix.

Question 2: Is it fair to say that EPA would like to see the U.S. lessen its dependence on coal for electricity production?

Answer: The EPA is implementing the provisions of the Clean Air Act to reduce harmful air pollution from electricity production, while still maintaining a diverse energy supply that includes an important role for coal and natural gas.

Question 3: The EPA will soon be announcing new proposed regulations regarding greenhouse gas emissions from existing power plants. Do commercially available technologies currently exist to capture and store carbon emissions at power plants?

If yes, where? At what cost? Will vendors be able to deal with the demand created by the regulations?

Answer: In the recently issued Clean Power Plan, the EPA did not propose that retrofit carbon capture and storage is the "best system of emission reduction... adequately demonstrated" for reducing CO₂ at existing power plants.

Question 4: The power sector has announced the retirement of over 60 giga-watts of coal fired generation. This amounts to about 20 percent of the existing coal-fired generating capacity in the United States. These retirements will generally occur before 2020, with a great majority of the retirements occurring by the 2016 Mercury and Air Toxics Standards ("MATS") deadline. This loss of coal fired capacity is likely to continue due to new EPA rules, including the new CO₂ regulations for existing power plants, regulation of coal ash, and regional/local control measures required to attain the more stringent ozone and fine PM_{2.5} standards. Furthermore, electric reliability problems posed by the continued loss of coal fired capacity could be exacerbated by the retirement of baseload nuclear generation. According to a recent white paper by Senator Murkowski: "Just last year, four nuclear reactors were closed, and a fifth unit is scheduled to close in 2014. Two of these facilities ... cited economic reasons as the basis for their closures even though the facilities received license renewals."⁴ The power sector faces major challenges as to how it will replace a large amount of coal and nuclear baseload capacity. Please explain how the Agency intends to address this issue with regards to the upcoming section III (d) rule, including the steps it plans to take to ensure the reliability of the grid.

⁴ See Murkowski White Paper at page 9, footnote 41.

Answer: With an all-of-the-above approach, the Clean Power Plan recognizes that state plans for emission reductions can, and must, be consistent with a vibrant and growing economy and supply of reliable, affordable electricity to support that economy. It further reflects the growing trend, as exemplified by many state and local energy policies and programs, to shift energy production away from carbon-intensive fuels to a modern, more sustainable system that puts greater reliance on renewable energy, energy efficiency, and other low-carbon energy options. Based on our analysis, we expect that coal, oil, and natural gas will have an important role in a diverse U.S. energy mix for years to come. Under the proposed Clean Power Plan, the EPA projects that coal would have a 31% share of generation and natural gas would have a 32% share of generation in 2030. EPA's analysis shows that the proposed Clean Power Plan is unlikely to have any significant effect on electricity reliability. If a local reliability concern arises, the EPA is confident that it can be managed with existing tools and processes – especially taking into consideration the timing and compliance flexibilities in the guidelines.

The EPA estimates that the combined public health and climate benefits from the Clean Power Plan will be worth an estimated \$55 billion to \$93 billion in 2030. The public health and climate benefits are associated with emissions reductions achieved by the proposed rule alone. When the EPA estimates the benefits for rules, we include other rules that place emissions limitations on sources, such as MATS, CAIR, and various State programs, in the “baseline.” This confirms that we have not double-counted any of the emissions, benefits, or costs that should be attributed to another rule.

Question 5: Given that efficiency improvements will be critical for lowering CO₂ emissions from power plant under any future section 111 (d) rule, what is the agency doing to remove the existing regulatory barriers to completing such efficiency improvement measures under the New Source Review program?

Answer: The EPA agrees that efficiency improvements can be a cost-effective way to reduce CO₂ emissions. The Clean Power Plan identifies efficiency improvements at fossil-fuel fired units as one of the building blocks of the best system of emission reduction for existing power plants. Under the proposed Clean Power Plan, states and units can work together to decide what kind of efficiency upgrades and emission changes might occur at a particular source. As a result of such flexibility and anticipated state involvement, the EPA expects that a limited number of affected sources would trigger NSR when states implement their plans. The EPA is requesting comment on whether, with adequate analysis and support, the state plan could include a provision that sources would not trigger NSR when complying with the standards of performance included in the state's Clean Power Plan.

Question 6: In the proposed rule, EPA makes its "adequately demonstrated" determination predominantly based on CCS demonstration projects that have received federal assistance under the Energy Policy Act of 2005 (EPAct05). Notably, three of the four commercial scale CCS demonstration relied on by EPA have all been allocated an investment tax credit that was

established for "clean coal facilities" under Section 1307 of EPAAct05. However, Congress has placed specific limitations on EPA's authority to set Section 111 standards based on demonstration projects that receive federal assistance under these EPAAct05 programs. Specifically, these statutory limitations expressly bar EPA from considering the three commercial-scale CCS demonstration projects in making a determination under Section 111 that CCS is adequately demonstrated. Please explain why the Agency is ignoring this statutory limitation in the pending NSPS rulemaking.

Answer: The EPA does not believe that these provisions preclude its determination. The EPA has issued a Notice of Data Availability (NODA) that notes the availability of a Technical Support Document (TSD), in the rulemaking docket that details its position on this issue. It explains, "EPA interprets these provisions to preclude EPA from relying solely on the experience of facilities that received EPAAct05 assistance, but not to preclude EPA from relying on the experience of such facilities in conjunction with other information." Moreover, EPA based its determination on a number of projects and other information including projects that did not receive any assistance under the EPAAct05. In addition, the agency extended the public comment period for January 2014 proposal by 60 days to allow adequate time for the public to review and comment on the contents of the NODA and TSD.

Question 7: EPA's proposed rule defining the term "Waters of the United States" should allow stakeholders sufficient time to submit a robust and meaningful response to the proposal. Stakeholders need adequate time to develop analytical, technical, and economic information in response to the proposal. I understand that EPA and the Corps have taken years to develop a proposed rule. Will you commit to providing the public no less than 180 days for public comment?

Answer: The EPA and the Corps published their proposed rule clarifying protection under the Clean Water Act in the *Federal Register* on April 21, which began a 91-day public comment period that ends on July 21, 2014. The agencies' proposed rule was made publicly available on March 25. On June 10, 2014, the agencies notified stakeholders that they would extend the public comment period to October 20, 2014. This extension provides the public with 182 days to provide comment.

Question 8: In the proposal of the rule redefining "Waters of the United States," ditches are now considered to be part of the definition of a "tributary," which make them now come under federal jurisdiction, no "significant nexus" analysis even needed. How many ditches are now going to be a "water of the U.S." under this rule? We have a lot of ditches in my part of the country and if EPA is in the game of regulating them, farmers and ranchers are going to be pretty upset. The agriculture exemptions are not enough, farmers and ranchers are still going to have to get NPDES permits and 404 permits for things like spraying fields and pastures near ditches and ponds.

Answer: The proposed waters of the U.S. rule do not regulate any new types of waters and does not broaden historical coverage of the Clean Water Act. It does not expand regulation of

ditches, as certain ditches are currently regulated under our existing regulations. It, in fact, proposes to reduce jurisdiction over ditches by excluding certain intermittent ditches which are considered to be jurisdictional under existing regulations and the December 2008 guidance which is currently in effect. The proposed rule does this in section (b) of the regulatory language which states: "The following are not waters of the United States notwithstanding whether they meet the terms of paragraphs (a)(1) through (7) of this section." This language means that if a ditch qualifies as being exempt under paragraph (b), then it is exempt regardless of whether the ditch meets the definition of a tributary.

Question 9: How many more farms will need an SPCC plan based on the proposed rule? Will more livestock operations need 402 NPDES permits under this rule? Will more landowners need 404 permits?

Answer: The U.S. Army Corps of Engineers' and EPA's proposed rule, if finalized, would result in a narrowing of the scope of Clean Water Act (CWA) jurisdiction compared with the agencies' historic interpretations and their existing regulations. As such, the agencies do not anticipate many additional (or more) farms will require SPCC Plans or CWA permits under the proposed rule than are required currently. However, the agencies recognize that their efforts to make CWA definitions clearer and more consistent could impact implementation of these programs for agriculture, and the agencies welcome comments on this issue during the public comment period on the proposed rule to ensure that concerns raised by farmers and the agricultural industry are addressed in the agencies' rulemaking.

Question 10: EPA proposed a rule to redefine a "water of the U.S." Is it true that, in looking at costs, EPA did not update 20 year-old studies for inflation? Did EPA analyze each program under the Clean Water Act and whether that program would be expanded with this change and by how much?

Answer: At the time the economic analysis was developed, 2010 permit data was the most current information available. The cost estimate in the economic analysis was based on 2010 dollars, and all cost and benefit information was adjusted accordingly. The EPA analyzed the proposed rule's expected impact to each program under the Clean Water Act. The methodology and findings are documented in "Economic Analysis of Proposed Revised Definition of Waters of the United States," March 2014, which is in the docket for the proposed Waters of the U.S. rule. The agency invites comments on this document as part of the public comment period on the proposed rule and will update the analysis to support the final rule.

Question 11: How long and how much money does it currently take on average to get a nationwide permit? Is it safe to say that increasing the number of waters under federal regulation, especially if you're including ditches, dry streams, and isolated ponds and puddles, will increase the average time it takes to get a permit and will increase the average cost to get a permit?

Answer: Clean Water Act Section 404 permits are issued by the U.S. Army Corps of Engineers, not by EPA, so specific expertise regarding the cost and processing time

for these permits lies with the Corps. EPA and the Corps developed an economic analysis of the expected benefits and costs of the agencies' proposed "Waters of the U.S." rulemaking, which is available at http://www2.epa.gov/sites/production/files/2014-03/documents/wus_proposed_rule_economic_analysis.pdf. The agencies believe that the proposed rule will benefit businesses by increasing efficiency in determining coverage of the Clean Water Act.

The agencies' proposed rule does not protect any new types of waters that have not historically been covered under the Clean Water Act. The rule actually proposes to reduce jurisdiction and exclude certain ephemeral and intermittent ditches. "Puddles" have never been jurisdictional and will remain non-jurisdictional under the proposed rule.

Question 12: Can a third party sue me under the Clean Water Act if you have told me my dry streambed is not a "water of the U.S." in the form of a "jurisdictional determination" (JD), but that individual wants it to be?

Answer: A Corps or EPA jurisdictional determination would not be binding on a third party in a citizen suit enforcement action. The jurisdictional determination would likely be considered by the Court, but would not be binding on it.

Question 13: What is the EPA's definition for "significant nexus"?

Answer: The EPA and the U.S. Army Corps of Engineers are proposing a definition of "significant nexus" within their proposed rule to help provide clarity regarding a term described in Supreme Court opinions but not previously defined by the agencies. We believe that providing such a definition will increase consistency and predictability for permit applicants, agencies, and the public, and we invite comments on the proposed definition during the public comment period.

More specifically, the definition for "significant nexus" in the proposed rule developed by EPA and the Army Corps of Engineers is as follows:

"The term significant nexus means that a water, including wetlands, either alone or in combination with other similarly situated waters in the Region (i.e., the watershed that drains to the nearest water identified in paragraphs (a)(1) through (3) of this section), significantly affects the chemical, physical, or biological integrity of a water identified in paragraphs (a)(1) through (3) of this section. For an effect to be significant, it must be more than speculative or insubstantial. Other waters, including wetlands, are similarly situated when they perform similar functions and are located sufficiently close together or sufficiently close to a 'water of the United States' so that they can be evaluated as a single landscape unit with regard to their effect on the chemical, physical, or biological integrity of a water identified in paragraphs (a)(1) through (3) of this section." See, e.g., 79 Federal Register 22188, 22263 (April 21, 2014). The Federal Register preamble discusses this proposed regulatory definition at *Id.* pp. 22211-22214.

Question 14: How do the states feel about you taking federal control over "all waters?" Have you left any waters under their control? Have you consulted them?

Answer: The proposed rule does not purport to make all waters jurisdictional, but clarifies those waters that are jurisdictional in a manner consistent with the Clean Water Act (CWA) as interpreted by the U.S. Supreme Court. In fact, under the proposed rule, certain features are clearly stated not to be waters of the U.S. subject to programs under the federal Clean Water Act. State and local governments have well-defined and long-standing relationships in implementing affected CWA programs and these relationships will not be altered by the proposed rule. Forty-six states and the Virgin Islands have been authorized to administer the National Pollutant Discharge Elimination (NPDES) program under Section 402, while two states administer the Section 404 program. This action will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Consistent with the EPA and Corps policy to promote communications between the agencies and state and local governments, and in recognition of the vital role states play in implementation of the CWA, the EPA voluntarily undertook federalism consultation for this effort and met the terms of E.O. 13132 and EPA guidance for implementing the Order. The EPA and the Corps are seeking public comment to determine the limits of these jurisdictional areas. We continue to have discussions and outreach with our state partners.

Question 15: This proposal greatly expands the current definition of "waters of the U.S." under the Clean Water Act, opening them up to permitting requirements for ponds, ditches, and even dry streambeds that only hold water when there is a rainfall event. How do you explain to the agriculture community what the agency is doing?

Answer: The agencies' proposed rule will not expand Clean Water Act (CWA) jurisdiction beyond its historic scope. CWA programs for decades have asserted that ponds, ditches, and ephemeral streams are subject to CWA programs as waters of the U.S. The proposed rule will cover fewer waters than the current regulatory definition, because current regulations have not yet been revised to reflect U.S. Supreme Court decisions in 2001 and 2006 that constrain the scope of waters of the U.S.; that is the purpose of this rulemaking. The EPA and the Corps have been conducting outreach across the country with a variety of stakeholder groups, including the agricultural community. All agricultural exemptions and exclusions from Clean Water Act requirements that have existed for nearly 40 years have been retained in the proposal. In addition, the agencies jointly worked with the U.S. Department of Agriculture to develop an interpretive rule to clarify the Section 404(f)(1)(a) exemption to include 56 specific National Resource Conservation Service conservation practices that protect or improve water quality will not be subject to Clean Water Act dredge and fill permitting requirements. It is important to emphasize that the interpretive rule identifies additional activities considered exempt from permitting under Section 404(f)(1)(A), but does not reduce, in any manner, the scope of agriculture, silviculture, and ranching activities currently exempt from permitting under Section 404(t)(1)(A) including, for example, plowing, seeding, cultivation, minor drainage, etc. Farmers and producers will be able to

undertake the specific conservation practices without notification or permitting by ensuring that practices benefit water quality and are in accordance with Natural Resources Conservation Service standards.

Question 16: Does this rule increase the number of "waters" that could come under federal jurisdiction? Industry, unanimously believes the answer is yes. Doesn't it logically follow that if more waters are jurisdictional, more permits will be required?

Answer: The agencies' proposed rule, if finalized, would result in a narrowing of the scope of Clean Water Act jurisdiction compared with the agencies' historic interpretations and their existing regulations. The proposed rule will cover fewer waters than the current regulatory definition, because current regulations have not been revised to reflect U.S. Supreme Court decisions in 2001 and 2006 that constrain the scope of waters of the U.S. The proposed rule will provide greater consistency, certainty, and predictability nationwide by clarifying where the Clean Water Act applies and also where it doesn't. On a case-by-case basis, the agencies' proposed rule could result in additional permits being required for types of waters whose jurisdictional status has been uncertain and confusing as a result of these Supreme Court decisions. However, by providing clearer definitions of key terms in a regulation, clear categories of waters that are never jurisdictional, the agencies believe the proposed rule will provide certainty to landowners, industry, and other stakeholders and help facilitate the permitting process, while on balance covering fewer waters than the Clean Water Act's historic scope.

Question 17: Administrator, you said the proposal will provide clarity. However, it is 371 pages long. If a landowner wants to know whether waters on his property will require a federal permit, do you think he will be "clear" about that after he reads a 300+ page document? Is it your purpose to write a regulation so broad and vague that EPA is saying that "every water is now under federal jurisdiction?" I do not believe this is the kind of clarity landowners are asking for, or the Commerce Clause of the Constitution and the Clean Water Act allows.

Answer: The Agency is seeking clarity through this proposed rule, of which the rule language is only two pages long. The changes to the regulatory text require additional identical pages due to the numerous places in the Code of Federal Regulations where we are proposing to change the definition of waters of the United States, as the definition will apply to all Clean Water Act programs. The remaining pages in the *Federal Register* are the preamble of the proposed rule. The preamble provides background on why the rule was proposed and also contains an appendix for the scientific support of the proposed rule and an appendix on the legal underpinnings and support. The preamble also solicits specific comments from the public on the proposed rule and presents a number of alternative options for the public to provide input on. The EPA neither intends nor believes that every water is now under federal jurisdiction, nor would the proposed rule have that effect.

Question 18: Last November, the EPA proposed Renewable Fuel Standard targets for 2014 that would blend less fuel than we blended last year, impacting the economy in Nebraska. It does so using an approach that I find to be inconsistent with the law and previous regulations by inserting considerations about fuel delivery infrastructure into the annual target setting process. What steps is EPA taking to fix this proposed rule and respond to the hundreds of thousands of comments submitted for your consideration? When do you expect the final rule to be released?

Answer: Since the 2014 RFS volume proposal was released, the EPA has met with multiple stakeholders to listen to their input on the proposed rule and to solicit any new and relevant data that should be factored into setting the volume standards for 2014. These stakeholders include representatives from the biofuel sector, the agricultural sector, petroleum refiners, environmental groups, and various other organizations and sectors. The EPA also received over 300,000 comments on the 2014 RFS proposal, which we are currently evaluating. We anticipate issuing a final rule before the end of June.

Question 19: EPA announced plans to change the pathway approval process for new biofuels – a definite step in the right direction to mitigate unnecessarily long delays and wait times for new biofuels producers. Unfortunately, whatever positive benefits might come out of this process have been negated by the Agency's simultaneous announcement that new applicants refrain from submitting applications for a 6-month period, until EPA's new guidance is released. Coupled with the EPA's 2014 proposed volume rule under the RFS, and an already slow pathway approval process, this action only further creates unneeded uncertainty.

Question 20: Is it realistic to think that the EPA can get new guidance out in a 6 month period? Will this new process be subject to OMB review?

Answer: As stated in the EPA's March program announcement, these improvements are anticipated to be completed in approximately six months. The EPA is committed to meeting that timeframe and intend to complete all necessary steps -- as required by applicable statutes, regulations and executive orders -- within that timeframe.

Question 21: Why did the EPA include a pause on new applications during this window of time? Have you assessed the impact of this approach on investors and on the innovation pipeline for new biofuels?

Answer: As explained in the March program announcement, the EPA is continuing to review pending petitions that are high priority and petitions for which substantial modeling has already been done. Because we intend to provide new guidance, we have suggested that parties may want to delay their submissions until the new guidance is provided. We understand the importance of this petition process for companies developing new biofuel technologies, and we firmly believe that the long-term performance of the petition process will benefit from our streamlining efforts.

Question 22: Your announcement states that you will be setting priorities for processing while you are working on revisions to your approval process. Please provide the Committee with the list of applications that you will be processing and those that you will not during this period of time.

Answer: The full list of petitions under review is available here: <http://www.epa.gov/otaq/fuels/renewablefuels/new-pathways/rfs2-pathways-review.htm> . The goal of this improvement process is to enable more timely and efficient decision-making for all petitions. EPA staff have contacted all of the parties with petitions under review to discuss their status. We have explained that review is continuing for high priority petitions (based on the criteria listed in the March program announcement) and pending petitions for which substantial modeling has been done. For other petitions, for example those based on corn ethanol, we have explained that as part of the improvement process we are launching a more automated review process for petitions using previously approved feedstocks and well known production process technologies.

Senator BOXER. Thank you. I am sorry I kind of rushed you at the end.

Ms. MCCARTHY. That is all right.

Senator BOXER. So I am so taken by some of my colleagues' comments, and I have such great relationships across the aisle, personal relationships, but this idea that the Republicans support cracking down on ozone and smog and particulate matter just isn't true. All you had to do is listen to these comments. They are opposed to everything EPA does, not just climate.

And I want to point out and put in the record the endangerment findings started under the Bush administration from too much carbon pollution. We know you need a certain amount in the air, but too much is dangerous. This is what it says. And it started with Bush and it was completed under Obama: Climate change threatens human health and well being in many ways, including impacts from increased extreme weather events: wildfire decreased air quality, diseases transmitted by insects, food, and water. Some of these impacts are already underway, and there are cases of kids, for example, swimming in lakes that used to be much colder; now they are warmer and there are different kinds of bacteria and amoebas, and one child got a brain disease swimming in a lake in Ohio. And we will put all that into the record.

[The referenced documents follows:]



Federal Register

Tuesday,
December 15, 2009

Part V

**Environmental
Protection Agency**

40 CFR Chapter I
Endangerment and Cause or Contribute
Findings for Greenhouse Gases Under
Section 202(a) of the Clean Air Act; Final
Rule

ENVIRONMENTAL PROTECTION AGENCY**40 CFR Chapter I**

[EPA-HQ-OAR-2009-0171; FRL-9091-8]

RIN 2060-ZA14

Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: The Administrator finds that six greenhouse gases taken in combination endanger both the public health and the public welfare of current and future generations. The Administrator also finds that the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas air pollution that endangers public health and welfare under CAA section 202(a). These Findings are based on careful consideration of the full weight of scientific evidence and a thorough review of numerous public comments received on the Proposed Findings published April 24, 2009.

DATES: These Findings are effective on January 14, 2010.

ADDRESSES: EPA has established a docket for this action under Docket ID No. EPA-HQ-OAR-2009-0171. All documents in the docket are listed on the www.regulations.gov Web site. Although listed in the index, some information is not publicly available, e.g., confidential business information (CBI) or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through www.regulations.gov or in hard copy at EPA's Docket Center, Public Reading Room, EPA West Building, Room 3334, 1301 Constitution Avenue, NW., Washington, DC 20004. This Docket Facility is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air Docket is (202) 566-1742.

FOR FURTHER INFORMATION CONTACT:

Jeremy Martinich, Climate Change Division, Office of Atmospheric Programs (MC-6207), Environmental Protection Agency, 1200 Pennsylvania

Ave., NW., Washington, DC 20460; telephone number: (202) 343-9927; fax number: (202) 343-2202; e-mail address: ghgendangerment@epa.gov. For additional information regarding these Findings, please go to the Web site <http://www.epa.gov/climatechange/endangerment.html>.

SUPPLEMENTARY INFORMATION:**Judicial Review**

Under CAA section 307(b)(1), judicial review of this final action is available only by filing a petition for review in the U.S. Court of Appeals for the District of Columbia Circuit by February 16, 2010. Under CAA section 307(d)(7)(B), only an objection to this final action that was raised with reasonable specificity during the period for public comment can be raised during judicial review. This section also provides a mechanism for us to convene a proceeding for reconsideration. "[i]f the person raising an objection can demonstrate to EPA that it was impracticable to raise such objection within [the period for public comment] or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of this rule." Any person seeking to make such a demonstration to us should submit a Petition for Reconsideration to the Office of the Administrator, Environmental Protection Agency, Room 3000, Ariel Rios Building, 1200 Pennsylvania Ave., NW., Washington, DC 20004, with a copy to the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section, and the Associate General Counsel for the Air and Radiation Law Office, Office of General Counsel (Mail Code 2344A), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20004.

Acronyms and Abbreviations. The following acronyms and abbreviations are used in this document.

ACUS Administrative Conference of the United States
ANPR Advance Notice of Proposed Rulemaking
APA Administrative Procedure Act
GAA Clean Air Act
CAFE Corporate Average Fuel Economy
CAIT Climate Analysis Indicators Tool
CASAC Clean Air Scientific Advisory Committee
CBI Confidential Business Information
CCSP Climate Change Science Program
CFCs chlorofluorocarbons
CFR Code of Federal Regulations
CH₄ methane
CO₂ carbon dioxide
CO₂e CO₂-equivalent
CRU Climate Research Unit

DOT U.S. Department of Transportation
EO Executive Order
EPA U.S. Environmental Protection Agency
FR Federal Register
GHG greenhouse gas
GWP global warming potential
HadCRUT Hadley Centre/Climate Research Unit (CRU) temperature record
HCFCs hydrochlorofluorocarbons
HFCs hydrofluorocarbons
IA Interim Assessment report
IPCC Intergovernmental Panel on Climate Change
MPC miles per gallon
MWP Medieval Warm Period
N₂O nitrous oxide
NAAQS National Ambient Air Quality Standards
NAICS North American Industry Classification System
NASA National Aeronautics and Space Administration
NF₃ nitrogen trifluoride
NHTSA National Highway Traffic Safety Administration
NOAA National Oceanic and Atmospheric Administration
NOI Notice of Intent
NO_x nitrogen oxides
NRC National Research Council
NSPS new source performance standards
NTTA National Technology Transfer and Advancement Act of 1995
OMB Office of Management and Budget
PFCs perfluorocarbons
PM particulate matter
PSD Prevention of Significant Deterioration
RFA Regulatory Flexibility Act
SF₆ sulfur hexafluoride
SIP State Implementation Plan
TSD technical support document
U.S. United States
UMRA Unfunded Mandates Reform Act of 1995
UNFCCC United Nations Framework Convention on Climate Change
USGCRP U.S. Global Climate Research Program
VOC volatile organic compound(s)
WCI Western Climate Initiative
WRI World Resources Institute

TABLE OF CONTENTS

I. Introduction	A. Overview
	B. Background Information Helpful To Understand These Findings
	1. Greenhouse Gases and Transportation Sources Under CAA Section 202(a)
	2. Joint EPA and Department of Transportation Proposed Greenhouse Gas Rule
	C. Public Involvement
	1. EPA's Initial Work on Endangerment
	2. Public Involvement Since the April 2009 Proposed Endangerment Finding
	3. Issues Raised Regarding the Rulemaking Process
II. Legal Framework for This Action	A. Section 202(a) of the CAA—Endangerment and Cause or Contribute
	1. The Statutory Framework
	2. Summary of Response to Key Legal Comments on the Interpretation of the CAA Section 202(a) Endangerment and Cause or Contribute Test

B. Air Pollutant, Public Health and Welfare
III. EPA's Approach for Evaluating the Evidence Before It

- A. The Science on Which the Decisions Are Based
B. The Law on Which the Decisions Are Based
C. Adaptation and Mitigation
D. Geographic Scope of Impacts
E. Temporal Scope of Impacts
F. Impacts of Potential Future Regulations and Processes that Generate Greenhouse Gas Emissions

IV. The Administrator's Finding That Emissions of Greenhouse Gases Endanger Public Health and Welfare

- A. The Air Pollution Consists of Six Key Greenhouse Gases
1. Common Physical Properties of the Six Greenhouse Gases
2. Evidence That the Six Greenhouse Gases Are the Primary Driver of Current and Projected Climate Change
3. The Six Greenhouse Gases Are Currently the Common Focus of the Climate Change Science and Policy Communities
4. Defining Air Pollution as the Aggregate Group of Six Greenhouse Gases Is Consistent With Evaluation of Risks and Impacts Due to Human-Induced Climate Change
5. Defining the Air Pollution as the Aggregate Group of Six Greenhouse Gases Is Consistent With Past EPA Practice
6. Other Climate Forcers Not Being Included in the Definition of Air Pollution for This Finding
7. Summary of Key Comments on Definition of Air Pollution
B. The Air Pollution Is Reasonably Anticipated To Endanger Both Public Health and Welfare
1. The Air Pollution Is Reasonably Anticipated To Endanger Public Health
2. The Air Pollution Is Reasonably Anticipated To Endanger Public Welfare
V. The Administrator's Finding That Greenhouse Gases From CAA Section 202(a) Sources Cause or Contribute to the Endangerment of Public Health and Welfare
A. The Administrator's Definition of the "Air Pollutant"
B. The Administrator's Finding Whether Emissions of the Air Pollutant From Section 202(a) Source Categories Cause or Contribute to the Air Pollution That May Be Reasonably Anticipated To Endanger Public Health and Welfare
C. Response to Key Comments on the Administrator's Cause or Contribute Finding
1. The Administrator Reasonably Defined the "Air Pollutant" for the Cause or Contribute Analysis
2. The Administrator's Cause or Contribute Analysis Was Reasonable
VI. Statutory and Executive Reviews
A. Executive Order 12866: Regulatory Planning and Review
B. Paperwork Reduction Act
C. Regulatory Flexibility Act
D. Unfunded Mandates Reform Act
E. Executive Order 13132: Federalism

- F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments
G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks
H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use
I. National Technology Transfer and Advancement Act
J. Executive Order 12899: Federal Actions To Address Environmental Justice in Minority Populations and Low-income Populations
K. Congressional Review Act

I. Introduction

A. Overview

Pursuant to CAA section 202(a), the Administrator finds that greenhouse gases in the atmosphere may reasonably be anticipated both to endanger public health and to endanger public welfare. Specifically, the Administrator is defining the "air pollution" referred to in CAA section 202(a) to be the mix of six long-lived and directly-emitted greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). In this document, these six greenhouse gases are referred to as "well-mixed greenhouse gases" in this document (with more precise meanings of "long lived" and "well mixed" provided in Section IV.A).

The Administrator has determined that the body of scientific evidence compellingly supports this finding. The major assessments by the U.S. Global Climate Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC), and the National Research Council (NRC) serve as the primary scientific basis supporting the Administrator's endangerment finding.¹ The Administrator reached her determination by considering both observed and projected effects of greenhouse gases in the atmosphere, their effect on climate, and the public health and welfare risks and impacts associated with such climate change. The Administrator's assessment focused on public health and public welfare impacts within the United States. She also examined the evidence with respect to impacts in other world regions, and she concluded that these impacts strengthen the case for endangerment to public health and welfare because

impacts in other world regions can in turn adversely affect the United States.

The Administrator recognizes that human-induced climate change has the potential to be far-reaching and multi-dimensional, and in light of existing knowledge, that not all risks and potential impacts can be quantified or characterized with uniform metrics. There is variety not only in the nature and potential magnitude of risks and impacts, but also in our ability to characterize, quantify and project such impacts into the future. The Administrator is using her judgment, based on existing science, to weigh the threat for each of the identifiable risks, to weigh the potential benefits where relevant, and ultimately to assess whether these risks and effects, when viewed in total, endanger public health or welfare.

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public health by evaluating the risks associated with changes in air quality, increases in temperatures, changes in extreme weather events, increases in food- and water-borne pathogens, and changes in aeroallergens. The evidence concerning adverse air quality impacts provides strong and clear support for an endangerment finding. Increases in ambient ozone are expected to occur over broad areas of the country, and they are expected to increase serious adverse health effects in large population areas that are and may continue to be in nonattainment. The evaluation of the potential risks associated with increases in ozone in attainment areas also supports such a finding.

The impact on mortality and morbidity associated with increases in average temperatures, which increase the likelihood of heat waves, also provides support for a public health endangerment finding. There are uncertainties over the net health impacts of a temperature increase due to decreases in cold-related mortality, but some recent evidence suggests that the net impact on mortality is more likely to be adverse, in a context where heat is already the leading cause of weather-related deaths in the United States.

The evidence concerning how human-induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods. Additionally, public health is expected to be

¹ Section III of these Findings discusses the science on which these Findings are based. In addition, the Technical Support Document (TSD) accompanying these Findings summarizes the major assessments from the USGCRP, IPCC, and NRC.

adversely affected by an increase in the severity of coastal storm events due to rising sea levels.

There is some evidence that elevated carbon dioxide concentrations and climate changes can lead to changes in aeroallergens that could increase the potential for allergenic illnesses. The evidence on pathogen borne disease vectors provides directional support for an endangerment finding. The Administrator acknowledges the many uncertainties in these areas. Although these adverse effects provide some support for an endangerment finding, the Administrator is not placing primary weight on these factors.

Finally, the Administrator places weight on the fact that certain groups, including children, the elderly, and the poor, are most vulnerable to these climate-related health effects.

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public welfare by evaluating numerous and far-ranging risks to food production and agriculture, forestry, water resources, sea level rise and coastal areas, energy, infrastructure, and settlements, and ecosystems and wildlife. For each of these sectors, the evidence provides support for a finding of endangerment to public welfare. The evidence concerning adverse impacts in the areas of water resources and sea level rise and coastal areas provides the clearest and strongest support for an endangerment finding, both for current and future generations. Strong support is also found in the evidence concerning infrastructure and settlements, as well as ecosystems and wildlife. Across the sectors, the potential serious adverse impacts of extreme events, such as wildfires, flooding, drought, and extreme weather conditions, provide strong support for such a finding.

Water resources across large areas of the country are at serious risk from climate change, with effects on water supplies, water quality, and adverse effects from extreme events such as floods and droughts. Even areas of the country where an increase in water flow is projected could face water resource problems from the supply and water quality problems associated with temperature increases and precipitation variability, as well as the increased risk of serious adverse effects from extreme events, such as floods and drought. The severity of risks and impacts is likely to increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

Overall, the evidence on risk of adverse impacts for coastal areas

provides clear support for a finding that greenhouse gas air pollution endangers the welfare of current and future generations. The most serious potential adverse effects are the increased risk of storm surge and flooding in coastal areas from sea level rise and more intense storms. Observed sea level rise is already increasing the risk of storm surge and flooding in some coastal areas. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. Even if there is a low probability of raising the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution. In addition, coastal areas face other adverse impacts from sea level rise such as land loss due to inundation, erosion, wetland submergence, and habitat loss. The increased risk associated with these adverse impacts also endangers public welfare, with an increasing risk of greater adverse impacts in the future.

Strong support for an endangerment finding is also found in the evidence concerning energy, infrastructure, and settlements, as well as ecosystems and wildlife. While the impacts on net energy demand may be viewed as generally neutral for purposes of making an endangerment determination, climate change is expected to result in an increase in electricity production, especially supply for peak demand. This may be exacerbated by the potential for adverse impacts from climate change on hydropower resources as well as the potential risk of serious adverse effects on energy infrastructure from extreme events. Changes in extreme weather events threaten energy, transportation, and water resource infrastructure. Vulnerabilities of industry, infrastructure, and settlements to climate change are generally greater in high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Climate change will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles. Over the 21st

century, changes in climate will cause some species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will likely alter ecosystem structure, function, and services, leading to predominantly negative consequences for biodiversity and the provision of ecosystem goods and services.

There is a potential for a net benefit in the near term² for certain crops, but there is significant uncertainty about whether this benefit will be achieved given the various potential adverse impacts of climate change on crop yield, such as the increasing risk of extreme weather events. Other aspects of this sector may be adversely affected by climate change, including livestock management and irrigation requirements, and there is a risk of adverse effect on a large segment of the total crop market. For the near term, the concern over the potential for adverse effects in certain parts of the agriculture sector appears generally comparable to the potential for benefits for certain crops. However, the body of evidence points towards increasing risk of net adverse impacts on U.S. food production and agriculture over time, with the potential for significant disruptions and crop failure in the future.

For the near term, the Administrator finds the beneficial impact on forest growth and productivity in certain parts of the country from elevated carbon dioxide concentrations and temperature increases to date is offset by the clear risk from the observed increases in wildfires, combined with risks from the spread of destructive pests and disease. For the longer term, the risk from adverse effects increases over time, such that overall climate change presents serious adverse risks for forest productivity. There is compelling reason to find that the support for a positive endangerment finding increases as one considers expected future conditions where temperatures continue to rise.

Looking across all of the sectors discussed above, the evidence provides compelling support for finding that greenhouse gas air pollution endangers the public welfare of both current and

² The temporal scope of impacts is discussed in more detail in Section III.C. The phrase "near term" as used in this document generally refers to the current time period from and the next few decades. The phrase "long term" generally refers to a time frame extending beyond that to approximately the middle to the end of this century.

future generations. The risk and the severity of adverse impacts on public welfare are expected to increase over time.

The Administrator also finds that emissions of well-mixed greenhouse gases from the transportation sources covered under CAA section 202(a)³ contribute to the total greenhouse gas air pollution, and thus to the climate change problem, which is reasonably anticipated to endanger public health and welfare. The Administrator is defining the air pollutant that contributes to climate change as the aggregate group of the well-mixed greenhouse gases. The definition of air pollutant used by the Administrator is based on the similar attributes of these substances. These attributes include the fact that they are sufficiently long-lived to be well mixed globally in the atmosphere, that they are directly emitted, and that they exert a climate warming effect by trapping outgoing, infrared heat that would otherwise escape to space, and that they are the focus of climate change science and policy.

In order to determine if emissions of the well-mixed greenhouse gases from CAA section 202(a) source categories contribute to the air pollution that endangers public health and welfare, the Administrator compared the emissions from these CAA section 202(a) source categories to total global and total U.S. greenhouse gas emissions, finding that these source categories are responsible for about 4 percent of total global well-mixed greenhouse gas emissions and just over 23 percent of total U.S. well-mixed greenhouse gas emissions. The Administrator found that these comparisons, independently and together, clearly establish that these emissions contribute to greenhouse gas concentrations. For example, the emissions of well-mixed greenhouse gases from CAA section 202(a) sources are larger in magnitude than the total well-mixed greenhouse gas emissions from every other individual nation with the exception of China, Russia, and India, and are the second largest emitter within the United States behind the electricity generating sector. As the Supreme Court noted, “[j]udged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming.” *Massachusetts v. EPA*, 549 U.S. 497, 525 (2007).

³ Section 202(a) source categories include passenger cars, heavy-, medium and light-duty trucks, motorcycles, and buses.

The Administrator's findings are in response to the Supreme Court's decision in *Massachusetts v. EPA*. That case involved a 1999 petition submitted by the International Center for Technology Assessment and 18 other environmental and renewable energy industry organizations requesting that EPA issue standards under CAA section 202(a) for the emissions of carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons from new motor vehicles and engines. The Administrator's findings are in response to this petition and are for purposes of CAA section 202(a).

B. Background Information Helpful To Understand These Findings

This section provides some basic information regarding greenhouse gases and the CAA section 202(a) source categories, as well as the ongoing joint-rulemaking on greenhouse gases by EPA and the Department of Transportation. Additional technical and legal background, including a summary of the Supreme Court's *Massachusetts v. EPA* decision, can be found in the Proposed Endangerment and Contribution Findings (74 FR 18886, April 24, 2009).

1. Greenhouse Gases and Transportation Sources Under CAA Section 202(a)

Greenhouse gases are naturally present in the atmosphere and are also emitted by human activities. Greenhouse gases trap the Earth's heat that would otherwise escape from the atmosphere, and thus form the greenhouse effect that helps keep the Earth warm enough for life. Human activities are intensifying the naturally-occurring greenhouse effect by adding greenhouse gases to the atmosphere. The primary greenhouse gases of concern that are directly emitted by human activities include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Other pollutants (such as aerosols) and other human activities, such as land use changes that alter the reflectivity of the Earth's surface, also cause climatic warming and cooling effects. In these Findings, the term “climate change” generally refers to the global warming effect plus other associated changes (e.g., precipitation effects, sea level rise, changes in the frequency and severity of extreme weather events) being induced by human activities, including activities that emit greenhouse gases. Natural causes also, contribute to climate change and climatic changes have occurred throughout the Earth's history. The concern now, however, is that the changes taking place in our atmosphere

as a result of the well-documented buildup of greenhouse gases due to human activities are changing the climate at a pace and in a way that threatens human health, society, and the natural environment. Further detail on the state of climate change science can be found in Section III of these Findings as well as the technical support document (TSD) that accompanies this action (www.epa.gov/climatechange/endangerment.html).

The transportation sector is a major source of greenhouse gas emissions both in the United States and in the rest of the world. The transportation sources covered under CAA section 202(a)—the section of the CAA under which these Findings occur—include passenger cars, light- and heavy-duty trucks, buses, and motorcycles. These transportation sources emit four key greenhouse gases: carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons. Together, these transportation sources are responsible for 23 percent of total annual U.S. greenhouse gas emissions, making this source the second largest in the United States behind electricity generation.⁴

Further discussion of the emissions data supporting the Administrator's cause or contribute finding can be found in Section V of these Findings, and the detailed greenhouse gas emissions data for section 202(a) source categories can be found in Appendix B of EPA's TSD.

2. Joint EPA and Department of Transportation Proposed Greenhouse Gas Rule

On September 15, 2009, EPA and the Department of Transportation's National Highway Safety Administration (NHTSA) proposed a National Program that would dramatically reduce greenhouse gas emissions and improve fuel economy for new cars and trucks sold in the United States. The combined EPA and NHTSA standards that make up this proposed National Program would apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, covering model years 2012 through 2016. They proposed to require these vehicles to meet an estimated combined average

⁴ The units for greenhouse gas emissions in these findings are provided in carbon dioxide equivalent units, where carbon dioxide is the reference gas and every other greenhouse gas is converted to its carbon dioxide equivalent by using the 100-year global warming potential (as estimated by the Intergovernmental Panel on Climate Change (IPCC), assigned to each gas. The reference gas used is CO₂, and therefore Global Warming Potential (GWP)-weighted emissions are measured in (megagrams of CO₂ equivalent (Mg CO₂ eq.)). In accordance with UNFCCC reporting procedures, the United States quantifies greenhouse gas emissions using the 100-year time frame values for GWPs established in the IPCC Second Assessment Report.

emissions level of 250 grams of carbon dioxide per mile, equivalent to 35.5 miles per gallon (MPG) if the automobile industry were to meet this carbon dioxide level solely through fuel economy improvements. Together, these proposed standards would cut carbon dioxide emissions by an estimated 950 million metric tons and 1.8 billion barrels of oil over the lifetime of the vehicles sold under the program (model years 2012–2016). The proposed rulemaking can be viewed at (74 FR 49454, September 28, 2009).

C. Public Involvement

In response to the Supreme Court's decision, EPA has been examining the scientific and technical basis for the endangerment and cause or contribute decisions under CAA section 202(a) since 2007. The science informing the decision-making process has grown stronger since our work began. EPA's approach to evaluating the science, including comments submitted during the public comment period, is further discussed in Section III.A of these Findings. Public review and comment has always been a major component of EPA's process.

1. EPA's Initial Work on Endangerment

As part of the *Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act* (73 FR 44353) published in July 2008, EPA provided a thorough discussion of the issues and options pertaining to endangerment and cause or contribute findings under the CAA. The Agency also issued a TSD providing an overview of all the major scientific assessments available at the time and emission inventory data relevant to the contribution finding (Docket ID No. EPA-HQ-OAR-2008-0318). The comment period for that *Advance Notice* was 120 days, and it provided an opportunity for EPA to hear from the public with regard to the issues involved in endangerment and cause or contribute findings as well as the supporting science. EPA received, reviewed and considered numerous comments at that time and this public input was reflected in the Findings that the Administrator proposed in April 2009. In addition, many comments were received on the TSD released with the *Advance Notice* and reflected in revisions to the TSD released in April 2009 to accompany the Administrator's proposal. All public comments on the *Advance Notice* are contained in the public docket for this action (Docket ID No. EPA-HQ-OAR-2008-0318) accessible through www.regulations.gov.

2. Public Involvement Since the April 2009 Proposed Endangerment Finding

The Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases (Proposed Findings) was published on April 24, 2009 (74 FR 18886). The Administrator's proposal was subject to a 60-day public comment period, which ended June 23, 2009, and also included two public hearings. Over 380,000 public comments were received on the Administrator's proposed endangerment and cause or contribute findings, including comments on the elements of the Administrator's April 2009 proposal, the legal issues pertaining to the Administrator's decisions, and the underlying TSD containing the scientific and technical information.

A majority of the comments (approximately 370,000) were the result of mass mail campaigns, which are defined as groups of comments that are identical or very similar in form and content. Overall, about two-thirds of the mass-mail comments received are supportive of the Findings and generally encouraged the Administrator both to make a positive endangerment determination and implement greenhouse gas emission regulations. Of the mass mail campaigns in disagreement with the Proposed Findings most either oppose the proposal on economic grounds (e.g., due to concern for regulatory measures following an endangerment finding) or take issue with the proposed finding that atmospheric greenhouse gas concentrations endanger public health and welfare. Please note that for mass mailer campaigns, a representative copy of the comment is posted in the public docket for this Action (Docket ID No. EPA-HQ-OAR-2009-0171) at www.regulations.gov.

Approximately 11,000 other public comments were received. These comments raised a variety of issues related to the scientific and technical information EPA relied upon in making the Proposed Findings, legal and procedural issues, the content of the Proposed Findings, and the implications of the Proposed Findings.

In light of the very large number of comments received and the significant overlap between many comments, EPA has not responded to each comment individually. Rather, EPA has summarized and provided responses to each significant argument, assertion and question contained within the totality of the comments. EPA's responses to some of the most significant comments are provided in these Findings. Responses to all significant issues raised by the

comments are contained in the 11 volumes of the Response to Comments document, organized by subject area (found in docket EPA-HQ-OAR-2009-0171).

3. Issues Raised Regarding the Rulemaking Process

EPA received numerous comments on process-related issues, including comments urging the Administrator to delay issuing the final findings, arguing that it was improper for the Administrator to sever the endangerment and cause or contribute findings from the attendant section 202(a) standards, arguing the final decision was preordained by the President's May vehicle announcement, and questioning the adequacy of the comment period. Summaries of key comments and EPA's responses are discussed in this section. Additional and more detailed responses can be found in the Response to Comments document, Volume 11. As noted in the Response to Comments document, EPA also received comments supporting the overall process.

a. It Is Reasonable for the Administrator To Issue the Endangerment and Cause or Contribute Findings Now

Though the Supreme Court did not establish a specific deadline for EPA to act, more than two and a half years have passed since the remand from the Supreme Court, and it has been 10 years since EPA received the original petition requesting that EPA regulate greenhouse gas emissions from new motor vehicles. EPA has a responsibility to respond to the Supreme Court's decision and to fulfill its obligations under current law, and there is good reason to act now given the urgency of the threat of climate change and the compelling scientific evidence.

Many commenters urge EPA to delay making final findings for a variety of reasons. They note that the Supreme Court did not establish a deadline for EPA to act on remand. Commenters also argue that the Supreme Court's decision does not require that EPA make a final endangerment finding, and thus that EPA has discretionary power and may decline to issue an endangerment finding, not only if the science is too uncertain, but also if EPA can provide "some reasonable explanation" for exercising its discretion. These commenters interpret the Supreme Court decision not as rejecting all policy reasons for declining to undertake an endangerment finding, but rather as dismissing solely the policy reasons EPA set forth in 2003. Some commenters cite language in the

Supreme Court decision regarding EPA's discretion regarding "the manner, timing, content, and coordination of its regulations," and the Court's declining to rule on "whether policy concerns can inform EPA's actions in the event that it makes" a CAA section 202(a) finding to support their position.

Commenters then suggest a variety of policy reasons that EPA can and should make to support a decision not to undertake a finding of endangerment under CAA section 202(a)(1). For example, they argue that a finding of endangerment would trigger several other regulatory programs—such as the Prevention of Significant Deterioration (PSD) provisions—that would impose an unreasonable burden on the economy and government, without providing a benefit to the environment. Some commenters contend that EPA should defer issuing a final endangerment finding while Congress considers legislation. Many commenters note the ongoing international discussions regarding climate change and state their belief that unilateral EPA action would interfere with those negotiations. Others suggest deferring the EPA portion of the joint U.S. Department of Transportation (DOT)/EPA rulemaking because they argue that the new Corporate Average Fuel Economy (CAFE) standards will effectively result in lower greenhouse gas emissions from new motor vehicles, while avoiding the inevitable problems and concerns of regulating greenhouse gases under the CAA.

Other commenters argue that the endangerment determination has to be made on the basis of scientific considerations only. These commenters state that the Court was clear that "[t]he statutory question is whether sufficient information exists to make an endangerment finding," and thus, only if "the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming," may EPA avoid making a positive or negative endangerment finding. Many commenters urge EPA to take action quickly. They note that it has been 10 years since the original petition requesting that EPA regulate greenhouse gas emissions from motor vehicles was submitted to EPA. They argue that climate change is a serious problem that requires immediate action.

EPA agrees with the commenters who argue that the Supreme Court decision held that EPA is limited to consideration of science when undertaking an endangerment finding, and that we cannot delay issuing a finding due to policy concerns if the

science is sufficiently certain (as it is here). The Supreme Court stated that "EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do" 549 U.S. at 533. Some commenters point to this last provision, arguing that the policy reasons they provide are a "reasonable explanation" for not moving forward at this time. However, this ignores other language in the decision that clearly indicates that the Court interprets the statute to allow for the consideration only of science. For example, in rejecting the policy concerns expressed by EPA in its 2003 denial of the rulemaking petition, the Court noted that "it is evident [the policy considerations] have nothing to do with whether greenhouse gas emissions contribute to climate change. Still less do they amount to a reasoned justification for declining to form a scientific judgment" *Id.* at 533–34 (emphasis added).

Moreover, the Court also held that "[t]he statutory question is whether sufficient information exists to make an endangerment finding" *Id.* at 534. Taken as a whole, the Supreme Court's decision clearly indicates that policy reasons do not justify the Administrator avoiding taking further action on the question here.

We also note that the language many commenters quoted from the Supreme Court decision about EPA's discretion regarding the manner, timing and content of Agency actions, and the ability to consider policy concerns, relate to the motor vehicle standards required in the event that EPA makes a positive endangerment finding, and not the finding itself. EPA has long taken the position that it does have such discretion in the standard-setting step under CAA section 202(a).

b. The Administrator Reasonably Proceeded With the Endangerment and Cause or Contribute Findings Separate From the CAA Section 202(a) Standard Rulemaking

As discussed in the Proposed Findings, typically endangerment and cause or contribute findings have been proposed concurrently with proposed standards under various sections of the CAA, including CAA section 202(a). EPA received numerous comments on its decision to propose the endangerment and cause or contribute findings separate from any standards under CAA section 202(a).

Commenters argue that EPA has no authority to issue an endangerment

determination under CAA section 202(a) separate and apart from the rulemaking to establish emissions standards under CAA section 202(a). According to these commenters, CAA section 202(a) provides only one reason to issue an endangerment determination, and that is as the basis for promulgating emissions standards for new motor vehicles; thus, it does not authorize such a stand-alone endangerment finding, and EPA may not create its own procedural rules completely divorced from the statutory text. They continue by stating that while CAA section 202(a) says EPA may issue emissions standards conditioned on such a finding, it does not say EPA may first issue an endangerment determination and then issue emissions standards. In addition, they contend, the endangerment proposal and the emissions standards proposal need to be issued together so commenters can fully understand the implications of the endangerment determination. Failure to do so, they argue, deprives the commenters of the opportunity to assess the regulations that will presumably follow from an endangerment finding. They also argue that the expected overlap between reductions in emissions of greenhouse gases from CAA section 202(a) standards issued by EPA and CAFE standards issued by DOT calls into question the basis for the CAA section 202(a) standards and the related endangerment finding, and that EPA is improperly motivated by an attempt to trigger a cascade of regulations under the CAA and/or to promote legislation by Congress.

EPA disagrees with the commenters' claims and arguments. The text of CAA section 202(a) is silent on this issue. It does not specify the timing of an endangerment finding, other than to be clear that emissions standards may not be issued unless such a determination has been made. EPA is exercising the procedural discretion that is provided by CAA section 202(a)'s lack of specific direction. The text of CAA section 202(a) envisions two separate actions by the Administrator: (1) A determination on whether emissions from classes or categories of new motor vehicles cause or contribute to air pollution that may reasonably be anticipated to endanger, and (2) a separate decision on issuance of appropriate emissions standards for such classes or categories. The procedure followed in this rulemaking, and the companion rulemaking involving emissions standards for light duty motor vehicles, is consistent with CAA section 202(a). EPA will issue final emissions standards for new motor

vehicles only if affirmative findings are made concerning contribution and endangerment, and such emissions standards will not be finalized prior to making any such determinations. While it would also be consistent with CAA section 202(a) to issue the greenhouse gas endangerment and contribution findings and emissions standards for new light-duty vehicles in the same rulemaking, e.g., a single proposal covering them and a single final rule covering them, nothing in CAA section 202(a) requires such a procedural approach, and nothing in the approach taken in this case violates the text of CAA section 202(a). Since Congress was silent on this issue, and more than one procedural approach may accomplish the requirements of CAA section 202(a), EPA has the discretion to use the approach considered appropriate in this case. Once the final affirmative contribution and endangerment findings are made, EPA has the authority to issue the final emissions standards for new light-duty motor vehicles; however, as the Supreme Court has noted, the agency has 'significant latitude as to the manner, timing, [and] content * * * of its regulations'*Massachusetts v. EPA*, 549 U.S. at 533. That includes the discretion to issue them in a separate rulemaking.

Commenters' argument would also lead to the conclusion that EPA could not make an endangerment finding for the entire category of new motor vehicles, as it is doing here, unless EPA also conducted a rulemaking that set emissions standards for all the classes and categories of new motor vehicles at the same time. This narrow procedural limitation would improperly remove discretion that CAA section 202(a) provides to EPA.

EPA has the discretion under CAA section 202(a) to consider classes or categories of new motor vehicles separately or together in making a contribution and endangerment determination. This discretion would be removed under commenters' interpretation, by limiting this to only those cases in which EPA was also ready to issue emissions standards for all of the classes or categories covered by the endangerment finding. However, nothing in the text of CAA section 202(a) places such a limit on EPA's discretion in determining how to group classes or categories of new motor vehicles for purposes of the contribution and endangerment findings. This limitation would not be appropriate, because the issues of contribution and endangerment are separate and distinct from the issues of setting emissions standards. EPA, in this case, is fully

prepared to go forward with the contribution and endangerment determination, while it is not ready to proceed with rulemaking for each and every category of new motor vehicles in the first rulemaking to set emissions standards. Section 202(a) of the CAA provides EPA discretion with regard to when and how it conducts its rulemakings to make contribution and endangerment findings, and to set emissions standards, and the text of CAA section 202(a) does not support commenters' attempt to limit such discretion.

Concerns have been raised that the failure to issue the proposed endangerment finding and the proposed emissions standard together preclude commenters from assessing and considering the implications of the endangerment finding and the regulations that would likely flow from such a finding. However, commenters have failed to explain how this interferes in any way with their ability to comment on the endangerment finding. In fact it does not interfere, because the two proposals address separate and distinct issues. The endangerment finding concerns the contribution of new motor vehicles to air pollution and the effect of that air pollution on public health or welfare. The emissions standards, which have been proposed (74 FR 49454, September 28, 2009), concern the appropriate regulatory emissions standards if affirmative findings are made on contribution and endangerment. These two proposals address different issues. While commenters have the opportunity to comment on the proposed emissions standards in that rulemaking, they have not shown, and cannot show, that they need to have the emissions standards proposal before them in order to provide relevant comments on the proposed contribution or endangerment findings. Further discussion of this issue can be found in Section II of these Findings, and discussion of the timing of this action and its relationship to other CAA provisions and Congressional action can be found in Section III of these Findings and Volume 11 of the Response to Comments document.

c. The Administrator's Final Decision Was Not Preordained by the President's May Vehicle Announcement

EPA received numerous comments arguing that the President's announcement of a new "National Fuel Efficiency Policy" on May 19, 2009 seriously undermines EPA's ability to provide objective consideration of and a legally adequate response to comments

objecting to the previously proposed endangerment findings.

Commenters' conclusion is based on the view that the President's announced policy requires EPA to promulgate greenhouse gas emissions standards under CAA section 202(a), that the President's and Administrator Jackson's announcement indicated that the endangerment rulemaking was but a formality and that a final endangerment finding was a fait accompli. Commenters argue that this means the result of this rulemaking has been preordained and the merits of the issues have been prejudged.

EPA disagrees. Commenters' arguments wholly exaggerate and mischaracterize the circumstances. In the April 24, 2009 endangerment proposal EPA was clear that the two steps in the endangerment provision have to be satisfied in order for EPA to issue emissions standards for new motor vehicles under CAA section 202(a) (74 FR at 18888, April 24, 2009). This was repeated when EPA issued the Notice of Upcoming Joint Rulemaking to Establish Vehicle GHG Emissions and CAFE Standards (74 FR 24007 May 22, 2009) (Notice of Intent or NOI). This was repeated again when EPA issued proposed greenhouse gas emissions standards for certain new motor vehicles (74 FR 49454, September 28, 2009). EPA has consistently made it clear that issuance of new motor vehicle standards requires and is contingent upon satisfaction of the two-part endangerment test.

On May 19, 2009 EPA issued the joint Notice of Intent, which indicated EPA's intention to propose new motor vehicle standards. All of the major motor vehicle manufacturers, their trade associations, the State of California, and several environmental organizations announced their full support for the upcoming rulemaking. Not surprisingly, on the same day the President also announced his full support for this action. Commenters, however, erroneously equate this Presidential support with a Presidential directive that requires EPA to prejudge and preordain the result of this rulemaking.

The only evidence they point to are simply indications of Presidential support. Commenters point to a press release, which unsurprisingly refers to the Agency's announcement as delivering on the President's commitment to enact more stringent fuel economy standards, by bringing "all stakeholders to the table and [coming] up with a plan" for solving a serious problem. The plan that was announced, of course, was a plan to conduct notice and comment

rulemaking. The press release itself states that President Obama "set in motion a new national policy," with the policy "aimed" at reducing greenhouse gas emissions for new cars and trucks. What was "set in motion" was a notice and comment rulemaking described in the NOI issued by EPA on the same day. Neither the President nor EPA announced a final rule or a final direction that day, but instead did no more than announce a plan to go forward with a notice and comment rulemaking. That is how the plan "delivers on the President's commitment" to enact more stringent standards. The announcement was that a notice and comment rulemaking would be initiated with the aim of adopting certain emissions standards.

That is no different from what EPA or any other agency states when it issues a notice of proposed rulemaking. It starts a process that has the aim of issuing final regulations if they are deemed appropriate at the end of the public process. The fact that an Agency proposes a certain result, and expects that a final rule will be the result of setting such a process in motion, is the ordinary course of affairs in notice and comment rulemakings. This does not translate into prejudging the final result or having a preordained result that de facto negates the public comment process. The President's press release of May 19, 2009 was a recognition that this notice and comment rulemaking process would be set in motion, as well as providing his full support for the Agency to go forward in this direction; it was no more than that.

The various stakeholders who announced their support for the plan that had been set in motion all recognized that full notice and comment rulemaking was part of the plan, and they all reserved their rights to participate in such notice and comment rulemaking. For example, see the letter of support from Ford Motor Company, which states that "Ford fully supports proposal and adoption of such a National Program, which we understand will be subject to full notice-and-comment rulemaking, affording all interested parties including Ford the right to participate fully, comment, and submit information, the results of which are not pre-determined but depend upon processes set by law."

d. The Notice and Comment Period Was Adequate

Many commenters argue that the 60-day comment period was inadequate. Commenters claim that a 60-day period was insufficient time to fully evaluate the science and other information that

informed the Administrator's proposal. Some commenters assert that because the comment period for the Proposed Finding substantially overlapped with the comment period for the Mandatory Greenhouse Gas Reporting Rule, as well as Congress' consideration of climate legislation, their ability to fully participate in the notice and comment period was "seriously compromised." Moreover, they continue, because EPA had not yet proposed CAA section 202(a) standards, there was no valid reason to fail to extend the comment period. Several commenters and other entities had also requested that EPA extend the comment period.

Some commenters assert that the notice provided by this rulemaking was "defective" because the Federal Register notice announcing the proposal had an error in the e-mail address for the docket. At least one commenter suggests that this error deprives potential commenters of their Due Process under the Fifth Amendment of the Constitution, citing *Armstrong v. Manzo*, 380 U.S. 545, 552 (1965), and that failure to "correct" the minor typographical error in the e-mail address and extend the comment period would make the rule "subject to reversal" in violation of the CAA, Administrative Procedure Act (APA), the Due Process clause of the Constitution, and EQ 12866.

Finally, for many of the same reasons that commenters argue a 60-day comment period was inadequate, several commenters request that EPA reopen and/or extend the comment period. One commenter requests that the comment period be reopened because there was new information regarding data used by EPA in the Proposed Findings. In particular, the commenter alleges that it recently became aware that one of the sources of global climate data had destroyed the raw data for its data set of global surface temperatures. The commenter argues that this alleged destruction of raw data violates scientific standards, calls into question EPA's reliance on that data in these Findings, and necessitates a reopening of the proceedings. Other commenters request that the comment period be extended and/or reopened due to the release of a Federal government document on the impact of climate change in the United States near the end of the comment period, as well as the release of an internal EPA staff document discussing the science.

The official public comment period on the proposed rule was adequate. First, a 60-day comment period satisfies the procedural requirements of CAA section 307 of the CAA, which requires

a 30-day comment period, and that the docket be kept open to receive rebuttal or supplemental information as follow-up to any hearings for 30 days following the hearings. EPA met those obligations here—the comment period opened on April 24, 2009, the last hearing was on May 21, 2009 and the comment period closed June 23, 2009.

Second, as explained in letters denying requests to extend the comment period, a very large part of the information and analyses for the Proposed Findings had been previously released in July 30, 2008, as part of the *Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act (ANPR)* (73 FR 44353). The public comment period for the ANPR is discussed above in Section I.C.1 of these Findings. The Administrator explained that the comment period for that ANPR was 120 days and that the major recent scientific assessments that EPA relied upon in the TSD released with the ANPR had previously each gone through their own public review processes and have been publicly available for some time. In other words, EPA has provided ample time for review, particularly with regard to the technical support for the Findings. See, for example, EPA Letter to Congressman Issa dated June 17, 2009, a copy of which is available at <http://epa.gov/climatechange/endangerment.html>.

Moreover, the comment period was not rendered insufficient merely because other climate-related proceedings were occurring simultaneously.

While one commenter suggests that the convergence of several different climate-related activities has "seriously compromised" their ability to participate in the comment process, that commenter was able to submit an 89 page comment on this proposal alone. Moreover, it is hardly rare that more than one rule is out for comment at the same time. As noted above, EPA has received a substantial number of significant comments on the Proposed Findings, and has thoroughly considered and responded to significant comments.

EPA finds no evidence that a typographical error in the docket e-mail address of the Federal Register notice announcing the proposal prevented the public from having a meaningful opportunity to comment, and therefore deprived them of due process. Although the minor error—which involved a word processing auto-correction that turned a short dash into a long dash—appeared in the FR version of the Proposed Findings, the e-mail address is correct

in the signature version of the Proposed Findings posted on EPA's Web site until publication in the *Federal Register*, and in the "Instructions for Submitting Written Comments" document on the Web site for the rulemaking. EPA has received over 190,000 e-mails to the docket e-mail address to date, so the minor typographical error appearing in only one location has not been an impediment to interested parties' e-mailing comments. Moreover, EPA provided many other avenues for interested parties to submit comments in addition to the docket e-mail address, including via www.regulations.gov, mail, and fax; each of these options have been utilized by many commenters. EPA is confident that the minor typographical error did not prevent anyone from submitting written comments, by e-mail or otherwise, and that the public was provided "meaningful participation in the regulatory process" as mentioned in EO 12866.

Our response regarding the request to reopen the comment period due to concerns about alleged destruction of raw global surface data is discussed more fully in the Response to Comments document, Volume 11. The commenter did not provide any compelling reason to conclude that the absence of these data would materially affect the trends in the temperature records or conclusions drawn about them in the assessment literature and reflected in the TSD. The Hadley Centre/Climate Research Unit (CRU) temperature record (referred to as HadCRUT) is just one of three global surface temperature records that EPA and the assessment literature refer to and cite. National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) also produce temperature records, and all three temperature records have been extensively peer reviewed. Analyses of the three global temperature records produce essentially the same long-term trends as noted in the Climate Change Science Program (CCSP) (2006) report "Temperature Trends in the Lower Atmosphere," IPCC (2007), and NOAA's study⁵ "State of the Climate in 2008". Furthermore, the commenter did not demonstrate that the allegedly destroyed data would materially alter the HadCRUT record or meaningfully hinder its replication. The raw data, a small part of which has not been public (for reasons described at: <https://www.uea.ac.uk/mac/comm/media/>

⁵ Peterson, T.C., and M.O. Baringer (Eds.) (2009) State of the Climate in 2008. *Bull. Amer. Meteor. Soc.*, 90, S1-S196.

[press/2009/nov/CRUupdate](http://www.uea.ac.uk/cru/data/temperature/)), are available in a quality-controlled (or homogenized, value-added) format and the methodology for developing the quality-controlled data is described in the peer reviewed literature (as documented at <http://www.cru.uea.ac.uk/cru/data/temperature/>).

The release of the U.S. Global Climate Research Program (USGCRP) report on impacts of climate change in the United States in June 2009 also did not necessitate extending the comment period. This report was issued by the USGCRP, formerly the Climate Change Science Program (CCSP), and synthesized information contained in prior CCSP reports and other synthesis reports, many of which had already been published (and were included in the TSD for the Proposed Findings). Further, the USGCRP report itself underwent notice and comment before it was finalized and released.

Regarding the internal EPA staff paper that came to light during the comment period, several commenters submitted a copy of the EPA staff paper with their comments; EPA's response to the issues raised by the staff paper are discussed in the Response to Comments document, Volume 1. The fact that some internal agency deliberations were made public during the comment period does not in and of itself call into question those deliberations. As our responses to comments explain, EPA considered the concerns noted in the staff paper during the proposal stage, as well as when finalizing the Findings. There was nothing about those internal comments that required an extension or reopening of the comment period.

Thus, the opportunity for comment fully satisfies the CAA and Constitutional requirement of Due Process. Cases cited by commenters do not indicate otherwise. The comment period and thorough response to comment documents in the docket indicate that EPA has given people an opportunity to be heard in a "meaningful time and a meaningful manner." *Armstrong v. Manzo*, 380 U.S. 545, 552 (1965). Interested parties had full notice of the rulemaking proceedings and a significant opportunity to participate through the comment process and multiple hearings.

For all the above reasons, EPA's denial of the requests for extension or reopening of the comment period was entirely reasonable in light of the extensive opportunity for public comment and heavy amount of public participation during the comment period. EPA has fully complied with all

applicable public participation requirements for this rulemaking.

e. These Findings Did Not Necessitate a Formal Rulemaking Under the Administrative Procedure Act

One commenter, with the support of others, requests that EPA undertake a formal rulemaking process for the Findings, on the record, in accordance with the procedures described in sections 556-557 of the Administrative Procedure Act (APA). The commenter requests a multi-step process, involving additional public notice, an on-the-record proceeding (e.g., formal administrative hearing) with the right of appeal, utilization of the Clean Air Scientific Advisory Committee (CASAC) and its advisory proceedings, and designation of representatives from other executive branch agencies to participate in the formal proceeding and any CASAC advisory proceeding.

The commenter asserts that while EPA is not obligated under the CAA to undertake these additional procedures, the Agency nonetheless has the legal authority to engage in such a proceeding. The commenter believes this proceeding would show that EPA is "truly committed to scientific integrity and transparency." The commenter cites several cases to argue that refusal to proceed on the record would be "arbitrary and capricious" or would be an "abuse of discretion." The allegation at the core of the commenter's argument is that profound and wide-ranging scientific uncertainties exist in the Proposed Findings and in the impacts on health and welfare discussed in the TSD. To support this argument, the commenter provides lengthy criticisms of the science. The commenter also argues that the regulatory cascade that would be "unleashed" by a positive endangerment finding warrants the more formal proceedings.

Finally, the commenter suggests that EPA engage in "formal rulemaking" procedures in part due to the Administrative Conference of the United States' (ACUS) recommended factors for engaging in formal rulemaking. The commenter argues that the current action is "complex," "open-ended," and the costs that errors in the action may pose are "significant."

EPA is denying the request to undertake an "on the record" formal rulemaking. EPA is under no obligation to follow the extraordinarily rarely used formal rulemaking provisions of the APA. First, CAA section 307(d), not APA sections 553 through 557, apply to certain specified actions, such as this

one. EPA has satisfied all the requirements of CAA section 307(d). Indeed, the commenter itself "is not asserting that the Clean Air Act expressly requires" the additional procedures it requests. Moreover, the commenter does not discuss how the suggested formal proceeding would fit into the informal rulemaking requirements of CAA section 307(d) that do apply.

Formal rulemaking is very rarely used by Federal agencies. The formal rulemaking provisions of the APA are only triggered when the statute explicitly calls for proceedings "on the record after opportunity for an agency hearing." *United States v. Florida East Coast Ry. Co.*, 410 U.S. 224, 241 (1973). The mere mention of the word "hearing" does not trigger the formal rulemaking provisions of the APA. *Id.* The CAA does not include the statutory phrase required to trigger the formal rulemaking provisions of the APA (and as noted above the APA does not apply in the first place). Congress specified that certain rulemakings under the CAA follow the rulemaking procedures outlined in CAA section 307(d) rather than the APA "formal rulemaking" commenter suggests.

Despite the inapplicability of the formal rulemaking provisions to this action, commenters suggest that to refuse to voluntarily undertake rulemaking provisions not preferred by Congress would make EPA's rulemaking action an "abuse of discretion." EPA disagrees with this claim, and cases cited by the commenter do not indicate otherwise. To support the idea that an agency decision to engage in informal rulemaking could be an abuse of discretion, commenter cites *Ford Motor Co. v. FTC*, 673 F.2d 1008 (9th Cir. 1981). In *Ford Motor Co.*, the court ruled that the FTC's decision regarding an automobile dealership should have been resolved through a rulemaking rather than an individualized adjudication. *Id.* at 1010. In that instance, the court favored "rulemaking" over adjudication—not "formal rulemaking" over the far more common "informal rulemaking." The case stands only for the non-controversial proposition that sometimes agency use of *adjudications* may rise to an abuse of discretion where a *rulemaking* would be more appropriate—whether formal or informal. The Commenter does not cite a single judicial opinion stating that an agency abused its discretion by following the time-tested and Congressionally-favored informal rulemaking provisions of the CAA or the APA instead of the rarely used formal APA rulemaking provisions.

The commenter also alludes to the possibility that the choice of informal rulemaking may be "arbitrary and capricious." EPA disagrees that the choice to follow the frequently used, and CAA required, informal rulemaking procedures is arbitrary and capricious. The commenter cites *Vermont Yankee Nuclear Power Corp. v. NRDC*, 435 U.S. 519 (1978) for the proposition that "extremely compelling circumstances" could lead to a court overturning agency action for declining to follow extraneous procedures. As the commenter notes, in *Vermont Yankee* the Supreme Court overturned a lower court decision for imposing additional requirements not required by applicable statutes. Even if the dicta in *Vermont Yankee* could be applied contrary to the holding of the case in the way the commenter suggests, EPA's decision to follow frequently used informal rulemaking procedures for this action is highly reasonable.

As for the ACUS factors the commenter cites in support of its request, as the commenter notes, the ACUS factors are mere recommendations. While EPA certainly respects the views of ACUS, the recommendations are not binding on the Agency. In addition, EPA has engaged in a thorough, traditional rulemaking process that ensures that any concerns expressed by the commenter have been addressed. EPA has fully satisfied all applicable law in their consideration of this rulemaking.

Finally, as explained in Section III of these Findings and the Response to Comments document, EPA's approach to evaluating the evidence before it was entirely reasonable, and did not require a formal hearing. EPA relied primarily on robust synthesis reports that have undergone peer review and comment. The Agency also carefully considered the comments received on the Proposed Findings and TSD, including review of attached studies and documents. The public has had ample opportunity to provide its views on the science, and the record supporting these final findings indicates that EPA carefully considered and responded to significant public comments. To the extent the commenter's concern is that a formal proceeding will help ensure the *right* action in response to climate change is taken, that is not an issue for these Findings. As discussed in Section III of these Findings, this science-based judgment is not the forum for considering the potential mitigation options or their impact.

H. Legal Framework for This Action

As discussed in the Proposed Findings, two statutory provisions of the

CAA govern the Administrator's Findings. Section 202(a) of the CAA sets forth a two-part test for regulatory action under that provision: Endangerment and cause or contribute. Section 302 of the CAA contains definitions of the terms "air pollutant" and "effects on welfare". Below is a brief discussion of these statutory provisions and how they govern the Administrator's decision, as well as a summary of significant legal comments and EPA's responses to them.

A. Section 202(a) of the CAA—Endangerment and Cause or Contribute

1. The Statutory Framework

Section 202(a)(1) of the CAA states that:

The Administrator shall by regulation prescribe (and from time to time revise) standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in [her] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

Based on the text of CAA section 202(a) and its legislative history, the Administrator interprets the two-part test as follows. Further discussion of this two-part test can be found in Section II of the preamble for the Proposed Findings. First, the Administrator is required to protect public health and welfare, but she is not asked to wait until harm has occurred. EPA must be ready to take regulatory action to prevent harm before it occurs. Section 202(a)(1) requires the Administrator to "anticipate" "danger" to public health or welfare. The Administrator is thus to consider both current and future risks. Second, the Administrator is to exercise judgment by weighing risks, assessing potential harms, and making reasonable projections of future trends and possibilities. It follows that when exercising her judgment the Administrator balances the likelihood and severity of effects. This balance involves a sliding scale: on one end the severity of the effects may be of great concern, but the likelihood low, while on the other end the severity may be less, but the likelihood high. Under either scenario, the Administrator is permitted to find endangerment. If the harm would be catastrophic, the Administrator is permitted to find endangerment even if the likelihood is small.

Because scientific knowledge is constantly evolving, the Administrator may be called upon to make decisions while recognizing the uncertainties and

limitations of the data or information available, as risks to public health or welfare may involve the frontiers of scientific or medical knowledge. At the same time, the Administrator must exercise reasoned decision making, and avoid speculative inquiries. Third, as discussed further below, the Administrator is to consider the cumulative impact of sources of a pollutant in assessing the risks from air pollution, and is not to look only at the risks attributable to a single source or class of sources. Fourth, the Administrator is to consider the risks to all parts of our population, including those who are at greater risk for reasons such as increased susceptibility to adverse health effects. If vulnerable subpopulations are especially at risk, the Administrator is entitled to take that point into account in deciding the question of endangerment. Here too, both likelihood and severity of adverse effects are relevant, including catastrophic scenarios and their probabilities as well as the less severe effects. As explained below, vulnerable subpopulations face serious health risks as a result of climate change.

In addition, by instructing the Administrator to consider whether emissions of an air pollutant cause or contribute to air pollution, the statute is clear that she need not find that emissions from any one sector or group of sources are the sole or even the major part of an air pollution problem. The use of the term "contribute" clearly indicates a lower threshold than the sole or major cause. Moreover, the statutory language in CAA section 202(a) does not contain a modifier on its use of the term contribute. Unlike other CAA provisions, it does not require "significant" contribution. See, e.g., CAA sections 111(b); 213(a)(2), (4). To be sure, any finding of a "contribution" requires some threshold to be met; a truly trivial or de minimis "contribution" might not count as such. The Administrator therefore has ample discretion in exercising her reasonable judgment in determining whether, under the circumstances presented, the cause or contribute criterion has been met. Congress made it clear that the Administrator is to exercise her judgment in determining contribution, and authorized regulatory controls to address air pollution even if the air pollution problem results from a wide variety of sources. While the endangerment test looks at the entire air pollution problem and the risks it poses, the cause or contribute test is designed to authorize EPA to identify and then address what may well be many

different sectors or groups of sources that are each part of—and thus contributing to—the problem.

This framework recognizes that regulatory agencies such as EPA must be able to deal with the reality that "[m]an's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations." See *Ethyl Corp. v. EPA*, 541 F.2d 1, 6 (DC Cir.), cert. denied 426 U.S. 941 (1976). Both "the Clean Air Act and common sense * * * demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable." See *Massachusetts v. EPA*, 549 U.S. at 506, n.7 (citing *Ethyl Corp.*).

The Administrator recognizes that the context for this action is unique. There is a very large and comprehensive base of scientific information that has been developed over many years through a global consensus process involving numerous scientists from many countries and representing many disciplines. She also recognizes that there are varying degrees of uncertainty across many of these scientific issues. It is in this context that she is exercising her judgment and applying the statutory framework. As discussed in the Proposed Findings, this interpretation is based on and supported by the language in CAA section 202(a), its legislative history and case law.

2. Summary of Response to Key Legal Comments on the Interpretation of the CAA Section 202(a) Endangerment and Cause or Contribute Test

EPA received numerous comments regarding the interpretation of CAA section 202(a) set forth in the Proposed Findings. Below is a brief discussion of some of the key adverse legal comments and EPA's responses. Other key legal comments and EPA's responses are provided in later sections discussing the Administrator's findings.

Additional and more detailed summaries and responses can be found in the Response to Comments document. As noted in the Response to Comments document, EPA also received comments supporting its legal interpretations.

a. The Administrator Properly Interpreted the Precautionary and Preventive Nature of the Statutory Language

Various commenters argue either that the endangerment test under CAA section 202(a) is not precautionary or preventive in nature, or that EPA's interpretation and application is so extreme that it is contrary to what Congress intended in 1977, and

effectively guarantees an affirmative endangerment finding. Commenters also argue that the endangerment test improperly shifts the burdens to the opponents of an endangerment finding and is tantamount to assuming the air pollution is harmful unless it is shown to be safe.

EPA rejects the argument that the endangerment test in CAA section 202(a) is not precautionary or preventive in nature. As discussed in more detail in the proposal, Congress relied heavily on the en banc decision in *Ethyl* when it revised section 202(a) and other CAA provisions to adopt the current language on endangerment and contribution. 74 FR 18886, 18891–2. The *Ethyl* court could not have been clearer on the precautionary nature of a criteria based on endangerment. The court rejected the argument that EPA had to find actual harm was occurring before it could make the required endangerment finding. The court stated that:

The Precautionary Nature of "Will Endanger." Simply as a matter of plain meaning, we have difficulty crediting petitioners' reading of the "will endanger" standard. The meaning of "endanger" is not disputed. Case law and dictionary definition agree that endanger means something less than actual harm. When one is endangered, harm is *threatened*; no actual injury need ever occur. Thus, for example, a town may be "endangered" by a threatening plague or hurricane and yet emerge from the danger completely unscathed. A statute allowing for regulation in the face of danger is, necessarily, a precautionary statute. Regulatory action may be taken before the threatened harm occurs; indeed, the very existence of such precautionary legislation would seem to demand that regulatory action precede, and, optimally, prevent, the perceived threat. As should be apparent, the "will endanger" language of Section 211(c)(1)(A) makes it such a precautionary statute. *Ethyl* at 13 (footnotes omitted).

Similarly, the court stated that "[i]n sum, based on the plain meaning of the statute, the juxtaposition of CAA section 211 with CAA sections 108 and 202, and the *Reserve Mining* precedent, we conclude that the "will endanger" standard is precautionary in nature and does not require proof of actual harm before regulation is appropriate." *Ethyl* at 17. It is this authority to act before harm has occurred that makes it a preventive, precautionary provision.

It is important to note that this statement was in the context of rejecting an argument that EPA had to prove actual harm before it could adopt fuel control regulations under then CAA section 211(c)(1). The court likewise rejected the argument that EPA had to show that such harm was "probable."

The court made it clear that determining endangerment entails judgments involving both the risk or likelihood of harm and the severity of the harm if it were to occur. Nowhere did the court indicate that the burden was on the opponents of an endangerment finding to show that there was no endangerment. The opinion focuses on describing the burden the statute places on EPA, rejecting *Ethyl's* arguments of a burden to show actual or probable harm.

Congress intentionally adopted a precautionary and preventive approach. It stated that the purpose of the 1977 amendments was to "emphasize the preventive or precautionary nature of the act, *i.e.*, to assure that regulatory action can effectively prevent harm before it occurs; to emphasize the predominate value of protection to public health."⁶ Congress also stated that it authorized the Administrator to weigh risks and make projections of future trends, a "middle road between those who would impose a nearly impossible standard of proof on the Administrator before he may move to protect public health and those who would shift the burden of proof for all pollutants to make the pollutant source prove the safety of its emissions as a condition of operation." Leg. His. at 2516.

Thus, EPA rejects commenters' arguments. Congress intended this provision to be preventive and precautionary in nature, however it did not shift the burden of proof to opponents of an endangerment finding to show safety or no endangerment. Moreover, as is demonstrated in the following, EPA has not shifted the burden of proof in the final endangerment finding, but rather is weighing the likelihood and severity of harms to arrive at the final finding. EPA has not applied an exaggerated or dramatically expanded precautionary principle, and instead has exercised judgment by weighing and balancing the factors that are relevant under this provision.

b. The Administrator Does Not Need To Find That the Control Measures Following an Endangerment Finding Would Prevent at Least a Substantial Part of the Danger in Order To Find Endangerment

Several commenters argue that it is unlawful for EPA to make an affirmative endangerment finding unless EPA finds

that the regulatory control measures contemplated to follow such a finding would prevent at least a substantial part of the danger from the global climate change at which the regulation is aimed. This hurdle is also described by commenters as the regulation "achieving the statutory objective of preventing damage", or "fruitfully attacking" the environmental and public health danger at hand by meaningfully and substantially reducing it. Commenters point to *Ethyl Corp. v. EPA*, 541 F.2d 1 (DC Cir. 1976) (en banc) as support for this view, as well as portions of the legislative history of this provision.

Commenters contend that EPA has failed to show that this required degree of meaningful reduction of endangerment would be achieved through regulation of new motor vehicles based on an endangerment finding. In making any such showing, commenters argue that EPA would need to account for the following: (1) The fact that any regulation would be limited to new motor vehicles, if not the subset of new motor vehicles discussed in the President's May 2009 announcement, (2) any increase in emissions from purchasers delaying purchases of new vehicles subject to any greenhouse gas emissions standards, or increasing the miles traveled of new vehicles with greater fuel economy, (3) the fact that only a limited portion of the new motor vehicle emissions of greenhouse gases would be controlled, (4) the fact that CAFE standards would effectively achieve the same reductions, and (5) the fact that any vehicle standards would not themselves reduce global temperatures. Some commenters refer to EPA's proposal for greenhouse gas emissions standards for new motor vehicles as support for these arguments, claiming the proposed new motor vehicle emission standards are largely duplicative of the standards proposed by the National Highway Traffic Safety Administration (NHTSA), and the estimates of the impacts of the proposed standards confirm that EPA's proposed standards cannot "fruitfully attack" global climate change (74 FR 49454, September 28, 2009).

Commenters attempt to read into the statute a requirement that is not there. EPA interprets the endangerment provision of CAA section 202(a) as not requiring any such finding or showing as described by commenters. The text of CAA section 202(a) does not support such an interpretation. The endangerment provision calls for EPA, in its judgment, to determine whether air pollution is reasonably anticipated to endanger public health or welfare, and

whether emissions from certain sources cause or contribute to such air pollution. If EPA makes an affirmative finding, then it shall set emissions standards applicable to emissions of such air pollutants from new motor vehicles. There is no reference in the text of the endangerment or cause or contribute provision to anything concerning the degree of reductions that would be achieved by the emissions standards that would follow such a finding. The Administrator's judgment is directed at the issues of endangerment and cause or contribute, not at how effective the resulting emissions control standards will be.

As in the several other similar provisions adopted in the 1977 amendments, in CAA section 202(a) Congress explicitly separated two different decisions to be made, providing different criteria for them. The first decision involves the air pollution and the endangerment criteria, and the contribution to the air pollution by the sources. The second decision involves how to regulate the sources to control the emissions if an affirmative endangerment and contribution finding are made. In all of the various provisions, there is broad similarity in the phrasing of the endangerment and contribution decision. However, for the decision on how to regulate, there are a wide variety of different approaches adopted by Congress. In some cases, EPA has discretion whether to issue standards or not, while in other cases, as in CAA section 202(a), EPA is required to issue standards. In some cases, the regulatory criteria are general, as in CAA section 202(a); in others, they provide significantly more direction as to how standards are to be set, as in CAA section 213(a)(4).

As the Supreme Court made clear in *Massachusetts v. EPA*, EPA's judgment in making the endangerment and contribution findings is constrained by the statute, and EPA is to decide these issues based solely on the scientific and other evidence relevant to that decision. EPA may not "rest[] on reasoning divorced from the statutory text," and instead EPA's exercise of judgment must relate to whether an air pollutant causes or contributes to air pollution that endangers. *Massachusetts v. EPA*, 549 U.S. at 532. As the Supreme Court noted, EPA must "exercise discretion within defined statutory limits." Id. at 533. EPA's belief one way or the other regarding whether regulation of greenhouse gases from new motor vehicles would be "effective" is irrelevant in making the endangerment and contribution decisions before EPA. Id. Instead "[t]he statutory question is

⁶ The Supreme Court recognized that the current language in section 202(a), adopted in 1977, is "more protective" than the 1970 version that was similar to the section 211 language before the DC Circuit in *Ethyl, Massachusetts v. EPA*, 549 U.S. at 506, fn 7.

whether sufficient information exists to make an endangerment finding." *Id.* at 534.

The effectiveness of a potential future control strategy is not relevant to deciding whether air pollution levels in the atmosphere endanger. It is also not relevant to deciding whether emissions of greenhouse gases from new motor vehicles contribute to such air pollution. Commenters argue that Congress implicitly imposed a third requirement, that the future control strategy have a certain degree of effectiveness in reducing the endangerment before EPA could make the affirmative findings that would authorize such regulation. There is no statutory text that supports such an interpretation, and the Supreme Court makes it clear that EPA has no discretion to read this kind of additional factor into CAA section 202(a)'s endangerment and contribution criteria. In fact, the Supreme Court rejected similar arguments that EPA had the discretion to consider various other factors besides endangerment and contribution in deciding whether to deny a petition. *Massachusetts v. EPA*, 549 U.S. at 532–35.

Commenters point to language from the *Ethyl* case to support their position, noting that the DC Circuit referred to the emissions control regulation adopted by EPA under CAA section 211(c) as one that would "fruitfully attack" the environmental and public health danger by meaningfully and substantially reducing the danger. It is important to understand the context for this discussion in *Ethyl*. The petitioner *Ethyl Corp.* argued that EPA had to show that the health threat from the emissions of lead from the fuel additive being regulated had to be considered in isolation, and the threat "in and of itself" from the additive had to meet the test of endangerment in CAA section 211(c). EPA had rejected this approach, and had interpreted CAA section 211(c)(1) as calling for EPA to look at the cumulative impact of lead, and to consider the impact of lead from emissions related to use of the fuel additive in the context all other human exposure to lead. The court rejected *Ethyl's* approach and supported EPA's interpretation. The DC Circuit noted that Congress was fully aware that the burden of lead on the body was caused by multiple sources and that it would be of no value to try and determine the effect on human health from the lead automobile emissions by themselves. The court specifically noted that "the incremental effect of lead emissions on the total body lead burden is of no practical value in determining whether

health is endangered," but recognized that this incremental effect is of value "in deciding whether the lead exposure problem can fruitfully be attacked through control of lead additives." *Ethyl*, 541 F.2d at 31 fn 62. The court made clear that the factor that was critically important to determining the effectiveness of the resulting control strategy—the incremental effect of automobile lead emissions on total body burden—was irrelevant and of no value in determining whether the endangerment criteria was met. Thus it is clear that the court in *Ethyl* did not interpret then CAA section 211(c)(1)(A) as requiring EPA to make a showing of the effectiveness of the resulting emissions control strategy, and instead found just the opposite, that the factors that would determine effectiveness are irrelevant to determining endangerment.

Commenters also cite to the legislative history, noting that Congress referred to the "preventive or precautionary nature of the Act, *i.e.*, to assure that regulatory action can effectively prevent harm before it occurs." Leg. Hist. at 2516. However, this statement by Congress is presented as an answer to the question on page 2515, "Should the Administrator act to prevent harm before it occurs or should he be authorized to regulate an air pollutant only if he finds actual harm has already occurred." Leg. Hist. at 2515. In this context, the discussion on page 2516 clearly indicates that there is no opportunity for prevention or precaution if the test is one of actual harm already occurring. This discussion does not say or imply that even if the harm has not occurred, you can not act unless you also show that your action will effectively address it. This discussion concerns the endangerment test, not the criteria for standard setting. The criteria for standard setting address how the agency should act to address the harm, and as the *Ethyl* case notes, the factors relevant to how to "fruitfully attack" the harm are irrelevant to determining whether the harm is one that endangers the public health or welfare.

As with current CAA section 202(a), there is no basis to conflate these two separate decisions and to read into the endangerment criteria an obligation that EPA show that the resulting emissions control strategy or strategies will have some significant degree of harm reduction or effectiveness in addressing the endangerment. The conflating of the two decisions is not supported in the text of this provision, by the Supreme Court in *Massachusetts v. EPA*, by the DC Circuit in *Ethyl*, or by Congress in the legislative history of this provision.

It would be an unworkable interpretation, calling for EPA to project out the result of perhaps not one, but even several, future rulemakings stretching over perhaps a decade or decades. Especially in the context of global climate change, the effectiveness of a control strategy for new motor vehicles would have to be viewed in the context of a number of future motor vehicle regulations, as well as in the larger context of the CAA and perhaps even global context. That would be an unworkable and speculative requirement to impose on EPA as a precondition to answering the public health and welfare issues before it, as they are separate and apart from the issues involved with developing, implementing and evaluating the effectiveness of emissions control strategies.

c. The Administrator Does Not Need To Find There Is Significant Risk of Harm

Commenters argue that Congress established a minimum requirement that there be a "significant risk of harm" to find endangerment. They contend that this requirement stemmed from the *Ethyl* case, and that Congress adopted this view. According to the commenters, the risk is the function of two variables: the nature of the hazard at issue and the likelihood of its occurrence. Commenters argue that Congress imposed a requirement that this balance demonstrate a "significant risk of harm" to strike a balance between the precautionary nature of the CAA and the burdensome economic and societal consequences of regulation.

There are two basic problems with the commenters' arguments. First, commenters equate "significant risk of harm" as the overall test for endangerment, however the *Ethyl* case and the legislative history treat the risk of harm as only one of the two components that are to be considered in determining endangerment.—. The two components are the likelihood or risk of a harm occurring, and the severity of harm if it were to occur. Second, commenters equate it to a minimum statutory requirement. However, while the court in the *Ethyl* case made it clear that the facts in that case met the then applicable endangerment criteria, it also clearly said it was not determining what other facts or circumstances might amount to endangerment, including cases where the likelihood of a harm occurring was less than a significant risk of the harm.

In the EPA rulemaking that led to the *Ethyl* case, EPA stated that the requirement to reduce lead in gasoline "is based on the finding that lead

particle emissions from motor vehicles present a significant risk of harm to the health of urban populations, particularly to the health of city children" (38 FR 33734, December 6, 1973). The court in *Ethyl* supported EPA's determination, and addressed a variety of issues. First, it determined that the "will endanger" criteria of then CAA section 211(c) was intended to be precautionary in nature. It rejected arguments that EPA had to show proof of actual harm, or probable harm. *Ethyl*, 541 F.2d at 13–20. It was in this context, evaluating petitioner's arguments on whether the likelihood of a harm occurring had to rise to the level of actual or probable harm, that the court approved of EPA's view that a significant risk of harm could satisfy the statutory criteria. The precautionary nature of the provision meant that EPA did not need to show that either harm was actually occurring or was probable.

Instead, the court made it clear that the concept of endangerment is "composed of reciprocal elements of risk and harm," *Ethyl* at 18. This means "the public health may properly be found endangered both by a lesser risk of a greater harm and by a greater risk of lesser harm. Danger depends upon the relation between the risk and harm presented by each case, and cannot legitimately be pegged to 'probable' harm, regardless of whether that harm be great or small." The *Ethyl* court pointed to the decision by the 8th Circuit in *Reserve Mining Co. v. EPA*, 514 F.2d 492 (8th Cir, 1975), which interpreted similar language under the Federal Water Pollution Control Act, where the 8th Circuit upheld an endangerment finding in a case involving "reasonable medical concern," or a "potential" showing of harm. This was further evidence that a minimum "probable" likelihood of harm was not required.

The *Ethyl* court made it clear that there was no specific magnitude of risk of harm occurring that was required. "Reserve Mining convincingly demonstrates that the magnitude of risk sufficient to justify regulation is inversely proportional to the harm to be avoided." *Ethyl* at 19. This means there is no minimum requirement that the magnitude of risk be "significant" or another specific level of likelihood of occurrence. You need to evaluate the risk of harm in the context of the severity of the harm if it were to occur. In the case before it, the *Ethyl* court noted that "the harm caused by lead poisoning is severe." Even with harm as severe as lead poisoning, EPA did not rely on "potential" risk or a "reasonable medical concern." Instead, EPA found

that there was a significant risk of this harm to health. This finding of a significant risk was less than the level of "probable" harm called for by the petitioner *Ethyl* Corporation but was "considerably more certain than the risk that justified regulation in *Reserve Mining* of a comparably 'fright-laden' harm." *Ethyl* at 19–20. The *Ethyl* court concluded that this combination of risk (likelihood of harm) and severity of harm was sufficient under CAA section 211(c). "Thus we conclude that however far the parameters of risk and harm inherent in the 'will endanger' standard might reach in an appropriate case, they certainly present a 'danger' that can be regulated when the harm to be avoided is widespread lead poisoning and the risk of that occurrence is 'significant.'" *Ethyl* at 20.

Thus, the court made it clear that the endangerment criteria was intended to be precautionary in nature, that the risk of harm was one of the elements to consider in determining endangerment, and that the risk of harm needed to be considered in the context of the severity of the potential harm. It also concluded that a significant risk of harm coupled with an appropriate severity of the potential harm would satisfy the statutory criteria, and in the case before it the Administrator was clearly authorized to determine endangerment where there was a significant risk of harm that was coupled with a severe harm such as lead poisoning.

Importantly, the court also made it clear that it was not determining a minimum threshold that always had to be met. Instead, it emphasized that the risk of harm and severity of the potential harm had to be evaluated on a case by case basis. The court specifically said it was not determining "however far the parameters of risk and harm * * * might reach in an appropriate case." *Ethyl* at 20. Also see *Ethyl* in 17 at 13. The court recognized that this balancing of risk and harm "must be confined to reasonable limits" and even absolute certainty of a de minimis harm might not justify government action. However, "whether a particular combination of slight risk and great harm, or great risk and slight harm constitutes a danger must depend on the facts of each case." *Ethyl* at fn 32 at 18.⁷

⁷ Commenters point to *Amer. Farm Bureau Ass'n v. EPA*, 559 F.3d 512, 533 (DC Cir. 2009) as supporting their argument. However, in that case the Court made clear that EPA's action was not subject to the endangerment criterion in CAA section 108 but instead was subject to CAA section 109's requirement that the primary NAAQS be requisite to protect the public health with an adequate margin of safety. Under that provision and

In some cases, commenters confuse matters by switching the terminology, and instead refer to effects that "significantly harm" the public health or welfare. As with the reference to "significant risk of harm," commenters fail to recognize that there are two different aspects that must be considered, risk of harm and severity of harm, and neither of these aspects has a requirement that there be a finding of "significance." The DC Circuit in *Ethyl* makes clear that it is the combination of these two aspects that must be evaluated for purposes of endangerment, and there is no requirement of "significance" assigned to either of the two aspects that must instead be evaluated in combination. Congress addressed concerns over burdensome economic and societal consequences in the various statutory provisions that provide the criteria for standard setting or other agency action if there is an affirmative endangerment finding. Those statutory provisions, for example, make standard setting discretionary or specify how cost and other factors are to be taken into consideration in setting standards. However, the issues of risk of harm and severity of harm if it were to occur are separate from the issues of the economic impacts of any resulting regulatory provisions (see below).

As is clear in the prior summary of the endangerment findings and the more detailed discussion later, the breadth of the sectors of our society that are affected by climate change and the time frames at issue mean there is a very wide range of risks and harms that need to be considered, from evidence of various harms occurring now to evidence of risks of future harms. The Administrator has determined that the body of scientific evidence compellingly supports her endangerment finding.

B. Air Pollutant, Public Health and Welfare

The CAA defines both "air pollutant" and "effects on welfare." We provide both definitions here again for convenience.

Air pollutant is defined as:

its case law, the Court upheld EPA's reasoned balancing of the uncertainty regarding the link between non-urban thoracic coarse PM and adverse health effects, the large population groups potentially exposed to these particles, and the nature and degree of the health effects at issue. Citing to EPA's reasoning at 71 FR 61193 in the final PM rule, the court explained that EPA need not wait for conclusive proof of harm before setting a NAAQS under section 109 for this kind of coarse PM. The Court's reference to EPA's belief that there may be a significant risk to public health is not stated as any sort of statutory minimum, but instead refers to the Agency's reasoning at 71 FR 61193, which displays a reasoned balancing of possibility of harm and severity of harm if it were to occur.

"Any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term 'air pollutant' is used." CAA section 302(g). As the Supreme Court held, greenhouse gases fit well within this capacious definition. See *Massachusetts v. EPA*, 549 U.S. at 532. They are "without a doubt" physical chemical substances emitted into the ambient air. *Id.* at 529.

"Regarding 'effects on welfare', the CAA states that [a]ll language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." CAA section 302(h).

As noted in the Proposed Findings, this definition is quite broad. Importantly, it is not an exclusive list due to the use of the term "includes, but is not limited to, * * * ." Effects other than those listed here may also be considered effects on welfare. Moreover, the terms contained within the definition are themselves expansive.

Although the CAA defines "effects on welfare" as discussed above, there are no definitions of "public health" or "public welfare" in the CAA. The Supreme Court has discussed the concept of public health in the context of whether costs of implementation can be considered when setting the health based primary National Ambient Air Quality Standards. *Whitman v. American Trucking Ass'n*, 531 U.S. 457 (2001). In *Whitman*, the Court imbued the term with its most natural meaning: "the health of the public. *Id.* at 466. In the past, when considering public health, EPA has looked at morbidity, such as impairment of lung function, aggravation of respiratory and cardiovascular disease, and other acute and chronic health effects, as well as mortality. See, e.g., *Final National Ambient Air Quality Standard for Ozone*, [73 FR 16436, 2007].

EPA received numerous comments regarding its proposed interpretations of

air pollutant and public health and welfare. Summaries of key comments and EPA's responses are discussed in Sections IV and V of these Findings. Additional and more detailed summaries and responses can be found in the Response to Comments document. As noted in the Response to Comments document, EPA also received comments supporting its legal interpretations.

III. EPA's Approach for Evaluating the Evidence Before It

This section discusses EPA's approach to evaluating the evidence before it, including the approach taken to the scientific evidence, the legal framework for this decision making, and several issues critical to determining the scope of the evaluation performed.

A. The Science on Which the Decisions Are Based

In 2007, EPA initiated its assessment of the science and other technical information to use in addressing the endangerment and cause or contribute issues before it under CAA section 202(a). This scientific and technical information was developed in the form of a TSD in 2007. An earlier draft of this document was released as part of the ANPR published July 30, 2008 (73 FR 44353). That earlier draft of the TSD relied heavily on the IPCC Fourth Assessment Report of 2007, key NRC reports, and a limited number of then-available synthesis and assessment products of the U.S. Climate Change Science Program (CCSP; now encompassed by USGCRP). EPA received a number of comments specifically focused on the TSD during the 120-day public comment period for the ANPR.

EPA revised and updated the TSD in preparing the Proposed Findings on endangerment and cause or contribute. Many of the comments received on the ANPR were reflected in the draft TSD released in April 2009 that served as the underlying scientific and technical basis for the Administrator's Proposed Findings, published April 24, 2009 (74 FR 18886). The draft TSD released in April 2009 also reflected the findings of 11 new synthesis and assessment products under the U.S. CCSP that had been published since July 2008.

The TSD that summarizes scientific findings from the major assessments of the USGCRP, the IPCC, and the NRC accompanies these Findings. The TSD is available at www.epa.gov/climatechange/endangerment.html and in the docket for this action. It also includes the most recent comprehensive assessment of the USGCRP, *Global*

Climate Change Impacts in the United States,⁸ published in June 2009. In addition, the TSD incorporates up-to-date observational data for a number of key climate variables from the NOAA, and the most up-to-date emissions data from EPA's annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, published in April, 2009.⁹ And finally, as discussed in Section I.B of these Findings, EPA received a large number of public comments on the Administrator's Proposed Findings, many of which addressed science issues either generally or specifically as reflected in the draft TSD released with the April 2009 proposal. A number of edits and updates were made to the draft TSD as a result of these comments.¹⁰

EPA is giving careful consideration to all of the scientific and technical information in the record, as discussed below. However, the Administrator is relying on the major assessments of the USGCRP, IPCC, and NRC as the primary scientific and technical basis of her endangerment decision for a number of reasons.

First, these assessments address the scientific issues that the Administrator must examine for the endangerment analysis. When viewed in total, these assessments address the issue of greenhouse gas endangerment by providing data and information on: (1) The amount of greenhouse gases being emitted by human activities; (2) how greenhouse gases have been and continue to accumulate in the atmosphere as a result of human activities; (3) changes to the Earth's energy balance as a result of the buildup of atmospheric greenhouse gases; (4) observed temperature and other climatic changes at the global and regional scales; (5) observed changes in other climate-sensitive sectors and systems of the human and natural environment; (6) the extent to which observed climate change and other changes in climate-sensitive systems can be attributed to the human-induced buildup of atmospheric greenhouse gases; (7) future projected climate change under a range of different scenarios of changing greenhouse gas emission rates; and (8) the projected risks and impacts to

⁸ Karl, T. J., Meehl, and T. Peterson (Eds.) (2009) *Global Climate Change Impacts in the United States*. Cambridge University Press, Cambridge, United Kingdom.

⁹ U.S. EPA (2009) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. EPA-430-R-09-004, Washington, DC.

¹⁰ EPA has placed within the docket a separate memo "Summary of Major Changes to the Technical Support Document" identifying where within the TSD such changes were made relative to the draft TSD released in April 2009.

human health, society and the environment.

Second, as indicated above, these assessments are recent and represent the current state of knowledge on the key elements for the endangerment analysis. It is worth noting that the June 2009 assessment of the USGCRP incorporates a number of key findings from the 2007 IPCC Fourth Assessment Report; such findings include the attribution of observed climate change to human emissions of greenhouse gases, and the future projected scenarios of climate change for the global and regional scales. This demonstrates that much of the underlying science that EPA has been utilizing since 2007 has not only been in the public domain for some time, but also has remained relevant and robust.

Third, these assessments are comprehensive in their coverage of the greenhouse gas and climate change problem, and address the different stages of the emissions-to-potential-harm chain necessary for the endangerment analysis. In so doing, they evaluate the findings of numerous individual peer-reviewed studies in order to draw more general and overarching conclusions about the state of science. The USGCRP, IPCC, and NRC assessments synthesize literally thousands of individual studies and convey the consensus conclusions on what the body of scientific literature tells us.

Fourth, these assessment reports undergo a rigorous and exacting standard of peer review by the expert community, as well as rigorous levels of U.S. government review and acceptance. Individual studies that appear in scientific journals, even if peer reviewed, do not go through as many review stages, nor are they reviewed and commented on by as many scientists. The review processes of the IPCC, USGCRP, and NRC (explained in fuller detail in the TSD and the Response to Comments document, Volume 1) provide EPA with strong assurance that this material has been well vetted by both the climate change research community and by the U.S. government. These assessments therefore essentially represent the U.S. government's view of the state of knowledge on greenhouse gases and climate change. For example, with regard to government acceptance and approval of IPCC assessment reports, the USGCRP Web site states that: "When governments accept the IPCC reports and approve their Summary for Policymakers, they acknowledge the legitimacy of their

scientific content."¹¹ It is the Administrator's view that such review and acceptance by the U.S. Government lends further support for placing primary weight on these major assessments.

It is EPA's view that the scientific assessments of the IPCC, USGCRP, and the NRC represent the best reference materials for determining the general state of knowledge on the scientific and technical issues before the agency in making an endangerment decision. No other source of information provides such a comprehensive and in-depth analysis across such a large body of scientific studies, adheres to such a high and exacting standard of peer review, and synthesizes the resulting consensus view of a large body of scientific experts across the world. For these reasons, the Administrator is placing primary and significant weight on these assessment reports in making her decision on endangerment.

A number of commenters called upon EPA to perform a new and independent assessment of all of the underlying climate change science, separate and apart from USGCRP, IPCC, and NRC. In effect, commenters suggest that EPA is either required to or should ignore the attributes discussed above concerning these assessment reports, and should instead perform its own assessment of all of the underlying studies and information.

In addition to the significant reasons discussed above for relying on and placing primary weight on these assessment reports, EPA has been a very active part of the U.S. government climate change research enterprise, and has taken an active part in the review, writing, and approval of these assessments. EPA was the lead agency for three significant reports under the USGCRP¹², and recently completed an

assessment addressing the climate change impacts on U.S. air quality—a report on which the TSD heavily relies for that particular issue. EPA was also involved in review of the IPCC Fourth Assessment Report, and in particular took part in the approval of the summary for policymakers for the Working Group II Volume, *Impacts, Adaptation and Vulnerability*.¹³ The USGCRP, IPCC, and NRC assessments have been reviewed and formally accepted by, commissioned by, or in some cases authored by, U.S. government agencies and individual government scientists. These reports already reflect significant input from EPA's scientists and the scientists of many other government agencies.

EPA has no reason to believe that the assessment reports do not represent the best source material to determine the state of science and the consensus view of the world's scientific experts on the issues central to making an endangerment decision with respect to greenhouse gases. EPA also has no reason to believe that putting this significant body of work aside and attempting to develop a new and separate assessment would provide any better basis for making the endangerment decision, especially because any such new assessment by EPA would still have to give proper weight to these same consensus assessment reports.

In summary, EPA concludes that its reliance on existing and recent synthesis and assessment reports is entirely reasonable and allows EPA to rely on the best available science.¹⁴ EPA also recognizes that scientific research is very active in many areas addressed in the TSD (e.g., aerosol effects on climate, climate feedbacks such as water vapor, and internal and external climate forcing mechanisms), as well as for some emerging issues (e.g., ocean acidification and climate change effects on water quality). EPA recognizes the potential importance of new scientific research, and the value of an ongoing process to take more recent science into account. EPA reviewed new literature in

Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks. (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA.

¹³ IPCC (2007) *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 978pp.

¹⁴ EPA maintains the highest level of adherence to Agency and OMB guidelines for data and scientific integrity and transparency. This is discussed in greater detail in EPA's Response to Comments document.

¹¹ <http://www.globalchange.gov/publications/reports/ipcc-reports>.

¹² CCSP (2009) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutterrez, E. Robert Thieler, and S. Jeffrey Williams (Lead Authors)]. U.S. Environmental Protection Agency, Washington DC, USA, 320 pp. CCSP (2008) *Preliminary review of adaptation options for climate-sensitive ecosystems and resources*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius S.H., J.M. West (eds.), I.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, 473 pp. CCSP (2008) *Analysis of the effects of global change on human health and welfare and human systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on

preparation of this TSD to evaluate its consistency with recent scientific assessments. We also considered public comments received and studies incorporated by reference. In a number of cases, the TSD was updated based on such information to add context for assessment literature findings, which includes supporting information and/or qualifying statements. In other cases, material that was not incorporated into the TSD is discussed within the Response to Comments document.

EPA reviewed these individual studies that were not considered or reflected in these major assessments to evaluate how they inform our understanding of how greenhouse gas emissions affect climate change, and how climate change may affect public health and welfare. Given the very large body of studies reviewed and assessed in developing the assessment reports, and the rigor and breadth of that review and assessment, EPA placed limited weight on the much smaller number of individual studies that were not considered or reflected in the major assessments. EPA reviewed them largely to see if they would lead EPA to change or place less weight on the judgments reflected in the assessment report. While EPA recognizes that some studies are more useful or informative than others, and gave each study it reviewed the weight it was due, the overall conclusion EPA drew from its review of studies submitted by commenters was that the studies did not change the various conclusions or judgments EPA would draw based on the assessment reports.

Many comments focus on the scientific and technical data underlying the Proposed Findings, such as climate change science and greenhouse gas emissions data. These comments cover a range of topics and are summarized and responded to in the Response to Public Comments document. The responses note those cases where a technical or scientific comment resulted in an editorial or substantive change to the TSD. The final TSD reflects all changes made as a result of public comments.

B. The Law on Which the Decisions Are Based

In addition to grounding these determinations on the science, they are also firmly grounded in EPA's legal authority. Section II of these Findings provides an in-depth discussion of the legal framework for the endangerment and cause or contribute decisions under CAA section 202(a), with additional discussion in Section II of the Proposed Finding (74 FR 18886, 18890, April 24,

2009). A variety of important legal issues are also discussed in Sections III, IV, and V of these Findings, as well as in the Response to Comments document, Volume 11. Section IV and V of these Findings explain the Administrator's decisions, and how she exercised her judgment in making the endangerment and contribution determinations, based on the entire scientific record before her and the legal framework structuring her decision making.

C. Adaptation and Mitigation

Following the language of CAA section 202(a), in which the Administrator, in her judgment, must determine if greenhouse gases constitute the air pollution that may be reasonably anticipated to endanger public health or welfare, EPA evaluated, based primarily on the scientific reports discussed above, how greenhouse gases and other climate-relevant substances are affecting the atmosphere and climate, and how these climate changes affect public health and welfare, now and in the future. Consistent with EPA's scientific approach underlying the Administrator's Proposed Findings, EPA did not undertake a separate analysis to evaluate potential societal and policy responses to any threat (*i.e.*, the endangerment) that may exist due to anthropogenic emissions of greenhouse gases. Risk reduction through adaptation and greenhouse gas mitigation measures is of course a strong focal area of scientists and policy makers, including EPA; however, EPA considers adaptation and mitigation to be potential responses to endangerment, and as such has determined that they are outside the scope of the endangerment analysis.

The Administrator's position is not that adaptation will not occur or cannot help protect public health and welfare from certain impacts of climate change, as some commenters intimated. To the contrary, EPA recognizes that some level of autonomous adaptation¹⁵ will occur, and commenters are correct that autonomous adaptation can affect the severity of climate change impacts.

¹⁵ The IPCC definition of adaptation: "Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities." The IPCC defines autonomous adaptation as "Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems."

Indeed, there are some cases in the TSD in which some degree of adaptation is accounted for; these cases occur where the literature on which the TSD relies already uses assumptions about autonomous adaptation when projecting the future effects of climate change. Such cases are noted in the TSD. We also view planned adaptation as an important near-term risk-minimizing strategy given that some degree of climate change will continue to occur as a result of past and current emissions of greenhouse gases that remain in the atmosphere for decades to centuries.

However, it is the Administrator's position that projections of adaptation and mitigation in response to risks and impacts associated with climate change are not appropriate for EPA to consider in making a decision on whether the air pollution endangers. The issue before EPA involves evaluating the risks to public health and welfare from the air pollution if we do not take action to address it. Adaptation and mitigation address an important but different issue—how much risk will remain assuming some projection of how people and society will respond to the threat.

Several commenters argue that it is arbitrary not to consider adaptation in determining endangerment. They contend that because endangerment is a forward-looking exercise, the fundamental inquiry concerns the type and extent of harm that is believed likely to occur in the future. Just as the Administrator makes projections of potential harms in the future, these commenters contend that the Administrator needs to consider the literature on adaptation that addresses the likelihood and the severity of potential effects. Commenters also note that since adaptation is one of the likely impacts of climate change, it is irrational to exclude it from consideration when the goal is to evaluate the risks and harms in the real world in the future, not the risks and harms in the hypothetical scenario that result if you ignore adaptation.

According to commenters, the Administrator must consider both autonomous adaptation and anticipatory adaptation. They contend that literature on adaptation makes it clear there is a significant potential for adaptation, and that it can reduce the likelihood or severity of various effects, including health effects, and could even avert what might otherwise constitute endangerment. Commenters note that EPA considered the adaptation of species in nature, and it is arbitrary to not also consider adaptation by humans. Moreover, they argue that there is great

certainty that adaptation will occur, and thus EPA is required to address it and make projections. They recommend that EPA look to historic responses to changes in conditions as an analogue in making projections, recognizing that life in the United States is likely to be quite different 50 or 100 years from now, irrespective of climate change.

Commenters argue that adaption needs to be considered because it is central to the statutory requirements governing the endangerment inquiry. EPA is charged to determine the type and extent of harms that are likely to occur, and they argue that this can not rationally be considered without considering adaptation. Since some degree of adaptation is likely to occur, they continue that such a projection of future actual conditions requires consideration of adaption to evaluate whether the future conditions amount to endangerment from the air pollution.

According to commenters, the issue therefore is focused on human and societal adaptation, which can come in a wide variety of forms, ranging from changes in personal behavioral patterns to expenditures of resources to change infrastructure, such as building and maintaining barriers to protect against sea level rise.

With regard to mitigation, commenters argue that EPA should consider mitigation strategies and their potential to alleviate harm from greenhouse gas emissions. They contend that it is unreasonable for EPA to assume that society will not undertake mitigation.

Section 202(a) of the CAA reflects the basic approach of many CAA sections—the threshold inquiry is whether the endangerment and cause or contribute criteria are satisfied, and only if they are met do the criteria for regulatory action go into effect. This reflects the basic separation of two different decisions—is this a health and welfare problem that should be addressed, and if so what are the appropriate mechanisms to address it? There is a division between identifying the health and welfare problem associated with the air pollution, and identifying the mechanisms used to address or solve the problem.

In evaluating endangerment, EPA is determining whether the risks to health and welfare from the air pollution amount to endangerment. As commenters recognize, that calls for evaluating and projecting the nature and types of risks from the air pollution, including the probability or likelihood of the occurrence of an impact and the degree of adversity (or benefit) of such an impact. This issue focuses on how

EPA makes such an evaluation in determining endangerment—does EPA look at the risks assuming no planned adaptation and/or mitigation, although EPA projects some degree is likely to occur, or does EPA look at the risks remaining after some projection of adaptation and/or mitigation?

These two approaches reflect different views of the core question EPA is trying to answer. The first approach most clearly focuses on just the air pollution and its impacts, and aims to separate this from the human and societal responses that may or should be taken in response to the risks from the air pollution. By its nature, this separation means this approach may not reflect the actual conditions in the real world in the future, because adaptation and/or mitigation may occur and change the risks. For example, adaptation would not change the atmospheric concentrations, or the likelihood or probability of various impacts occurring (e.g., it would not change the degree of sea level rise), but adaptation has the potential to reduce the adversity of the effects that do occur from these impacts. Mitigation could reduce the atmospheric concentrations that would otherwise occur, having the potential to reduce the likelihood or probability of various impacts occurring. Under this approach, the evaluation of risk is focused on the risk if we do not address the problem. It does not answer the question of how much risk we project will remain after we do address the problem, through either adaptation or mitigation or some combination of the two.

The second approach, suggested by commenters, would call for EPA to project into the future adaptation and/or mitigation, and the effect of these measures in reducing the risks to health or welfare from the air pollution. Commenters argue this will better reflect likely real world conditions, and therefore is needed to allow for an appropriate determination of whether EPA should, at this time, make an affirmative endangerment finding. However, this approach would not separate the air pollution and its impacts from the human and societal responses to the air pollution. It would intentionally and inextricably intertwine them. It would inexorably change the focus from how serious is the air pollution problem we need to address to how good a job are people and society likely to do in addressing or solving the problem. In addition it would dramatically increase the complexity of the issues before EPA.

The context for this endangerment finding is a time span of several decades

into the future. It involves a wide variety of differing health and welfare effects, and almost every sector in our society. This somewhat unique context tends to amplify the differences between the two different approaches. It also means that it is hard to cleanly implement either approach. For example, it is hard under the first approach to clearly separate impacts with and without adaption, given the nature of the scientific studies and information before us. Under the second approach it would be extremely hard to make a reasoned projection of human and societal adaptation and mitigation responses, because these are basically not scientific or technical judgments, but are largely political judgments for society or individual personal judgments.

However, the context for this endangerment finding does not change the fact that at their core the two different approaches are aimed at answering different questions. The first approach is focused on answering the question of what are the risks to public health and welfare from the air pollution if we do not take action to address it. The second approach is focused on answering the question of how much risk will remain assuming some projection of how people and society will respond.

EPA believes that it is appropriate and reasonable to interpret CAA section 202(a) as calling for the first approach. The structure of CAA section 202(a) and the various other similar provisions indicate an intention by Congress to separate the question of what is the problem we need to address from the question of what is the appropriate way to address it. The first approach is clearly more consistent with this statutory structure. The amount of reduction in risk that might be achieved through adaptation and/or mitigation is closely related to the way to address a problem, and is not focused on what is the problem that needs to be addressed. It helps gauge the likelihood of success in addressing a problem, and how good a job society may do in reducing risk; it is not at all as useful in determining the severity of the problem that needs to be addressed.

The endangerment issue at its core is a decision on whether there is a risk to health and welfare that needs to be addressed, and the second approach would tend to indicate that the more likely a society is to solve a problem, the less likely there is a problem that needs to be addressed. This would mask the issue and provide a directionally wrong signal. Assume two different situations, both presenting the same serious risks to

public health or welfare without consideration of adaptation or mitigation. The more successful society is projected to be in solving the serious problem in the future would mean the less likely we would be to make an endangerment finding at the inception identifying it as a problem that needs to be addressed. This is much less consistent with the logic embodied in CAA section 202(a), which separates the issue of whether there is a problem from the issue of what can be done to successfully address it.

In addition, the second approach would dramatically increase the complexity of the issues to resolve, and would do this by bringing in issues that are not the subject of the kind of scientific or technical judgments that Congress envisioned for the endangerment test. The legislative history indicates Congress was focused on issues of science and medicine, including issues at the frontiers of these fields. It referred to data, research resources, science and medicine, chemistry, biology, and statistics. There is no indication Congress envisioned exercising judgment on the very different types of issues involved in projecting the political actions likely to be taken by various local, State, and Federal governments, or judgments on the business or other decisions that are likely to be made by companies or other organizations, or the changes in personal behavior that may be occasioned by the adverse impacts of air pollution. The second approach would take EPA far away from the kind of judgments Congress envisioned for the endangerment test.

D. Geographic Scope of Impacts

It is the Administrator's view that the primary focus of the vulnerability, risk, and impact assessment is the United States. As described in Section IV of these Findings, the Administrator gives some consideration to climate change effects in world regions outside of the United States. Given the global nature of climate change, she has also examined potential impacts in other regions of the world. Greenhouse gases, once emitted, become well mixed in the atmosphere, meaning U.S. emissions can affect not only the U.S. population and environment, but other regions of the world as well. Likewise, emissions in other countries can affect the United States. Furthermore, impacts in other regions of the world may have consequences that in turn raise humanitarian, trade, and national security concerns for the United States.

Commenters argue that EPA does not have the authority to consider

international effects. They contend that the burden is on EPA to show endangerment based on impacts in the United States. They note that EPA proposed this approach, which is the only relevant issue for EPA. The purpose of CAA section 202(a), as the stated purpose of the CAA, commenters note, is to protect the quality of the nation's air resources and to protect the health and welfare of the U.S. population. Thus, they continue, international public health and welfare are not listed or stated, and are not encompassed by these provisions. Moreover, they argue that Congress addressed international impacts expressly in two other provisions of the CAA. They note that under CAA section 115, EPA considers emissions of pollutants that cause or contribute to air pollution that is reasonably anticipated to endanger public health or welfare in a foreign country, and that CAA section 179B addresses emissions of air pollutants in foreign countries that interfere with attainment of a National Ambient Air Quality Standards (NAAQS) in the United States. Because Congress intentionally addressed international impacts in those provisions, commenters argue that the absence of this direction in CAA section 202(a) means that EPA is not to consider international effects when assessing endangerment under this provision.

Commenters fail to recognize that EPA's consideration of international effects is directed at evaluating their impact on the public health and welfare of the U.S. population. EPA is not considering international effects to determine whether the health and welfare of the public in a foreign country is endangered. Instead, EPA's consideration of international effects for purposes of determining endangerment is limited to how those international effects impact the health and welfare of the U.S. population.

The Administrator looked first at impacts in the United States itself, and determined that these impacts are reasonably anticipated to endanger the public health and the welfare of the U.S. population. That remains the Administrator's position, and by itself supports her determination of endangerment. The Administrator also considered the effects of global climate change outside the borders of the United States and evaluated them to determine whether these international effects impact the U.S. population, and if so whether it impacts the U.S. population in a manner that supports or does not support endangerment to the health and welfare of the U.S. public. She is not evaluating international effects to

determine whether populations in a foreign country are endangered. The Administrator is looking at international effects solely for the purpose of evaluating their effects on the U.S. population.

For example, the U.S. population can be impacted by effects in other countries. These international effects can impact U.S. economic, trade, and humanitarian and national security interests. These would be potential effects on the U.S. population, brought about by the effects of climate change occurring outside the United States. It is fully reasonable and rational to expect that events occurring outside our borders can affect the U.S. population.

Thus, commenters misunderstand the role that international effects played in the proposal. The Administrator is not evaluating the impact of international effects on populations outside the United States; she is considering what impact these international effects could have on the U.S. population. That is fully consistent with the CAA's stated purpose of protecting the health and welfare of this nation's population.

E. Temporal Scope of Impacts

An additional parameter of the endangerment analysis is the timeframe. The Administrator's view is that the timeframe over which vulnerabilities, risks, and impacts are considered should be consistent with the timeframe over which greenhouse gases, once emitted, have an effect on climate. Thus the relevant time frame is decades to centuries for the primary greenhouse gases of concern. Therefore, in addition to reviewing recent observations, the underlying science upon which the Administrator is basing her findings generally considers the next several decades—the time period out to around 2100, and for certain impacts, the time period beyond 2100. How the accumulation of atmospheric greenhouse gases and resultant climate change may affect current and future generations is discussed in section IV in these Findings. By current generations we mean a near-term time frame of approximately the next 10 to 20 years; by future generations we mean a longer-term time frame extending beyond that. Some public comments were received that questioned making an endangerment finding based on current conditions, while others questioned EPA's ability to make an endangerment finding based on future projected conditions. Some of these comments are likewise addressed in Section IV in these Findings; and all comments on these temporal issues are addressed in the Response to Comments document.

F. Impacts of Potential Future Regulations and Processes That Generate Greenhouse Gas Emissions

This action is a stand-alone set of findings regarding endangerment and cause or contribute for greenhouse gases under CAA section 202(a), and does not contain any regulatory requirements. Therefore, this action does not attempt to assess the impacts of any future regulation. Although EPA would evaluate any future proposed regulation, many commenters argue that such a regulatory analysis should be part of the endangerment analysis.

Numerous commenters argue that EPA must fully consider the adverse and beneficial impacts of regulation together with the impacts of inaction, and describe this balancing as "risk-risk analysis," "health-health analysis," and most predominantly "risk tradeoff analysis." Commenters argue that EPA's final endangerment finding would be arbitrary unless EPA undertakes this type of risk trade-off analysis.

Commenters specifically argue that EPA must consider the economic impact of regulation, including the Prevention of Significant Deterioration (PSD) permitting program for major stationary sources because it is triggered by a CAA section 202(a) standard, when assessing whether there is endangerment to public welfare. In other words, they argue that the Administrator should determine if finding endangerment and regulating greenhouse gases under the CAA would be worse for public health and welfare than not regulating. Commenters also argue that the reference to "public" health or welfare in CAA section 202, as well as the fact that impacts on the economy should be considered impacts to welfare, especially requires EPA to consider the full range of possible impacts of regulation. Commenters provide various predictions regarding how regulating greenhouse gases under the CAA more broadly will impact the public, industry, states the overall economy, and thus, they conclude, public health and welfare. Examples of commenters' predictions include potential adverse impacts on (1) the housing industry and the availability of affordable housing, (2) jobs and income due to industry moving overseas, (3) the agriculture industry and its ability to provide affordable food, and (4) the nation's energy supply. They also cite to the letter from the Office of Management and Budget provided with the ANPR, as well as interagency comments on the draft Proposed Findings, in support of their argument.

At least one commenter argues that EPA fails to discuss the public health or

welfare benefits of the processes that produce the emissions. The commenter contends that for purposes of CAA section 202(a), this process would be the combustion of gasoline or other transportation fuel in new motor vehicles, and that for purposes of other CAA provisions with similar endangerment finding triggers, the processes would be the combustion of fossil fuel for electric generation and other activities. The commenter continues that EPA's decision to limit its analysis to the perceived detrimental aspects of emissions after they enter the atmosphere—as opposed to the possible positive aspects of emissions because of the processes that create the emissions—is based on EPA's overly narrow interpretation of both the meaning of the term "emission" in CAA section 202(a) (and therefore in other endangerment finding provisions) and the intent of these provisions. The commenter states that logically, it makes little sense to limit the definition of the term "emission" to only the "air pollutants" that are emitted. The commenter concludes that when EPA assesses whether the emission of greenhouse gases endanger public health and welfare, EPA must assess the dangers and benefits on both sides of the point where the emissions occur: in the atmosphere where the emissions lodge and, on the other side of the emitting stack or structure, in the processes that create the emissions. Otherwise, EPA will not be able to accurately assess whether the fact that society emits greenhouse gases is a benefit or a detriment. The commenter states that because greenhouse gas emissions, particularly carbon dioxide emissions, are so closely tied with all facets of modern life, a finding that greenhouse gas emissions endanger public health and welfare is akin to saying that modern life endangers public health or welfare. The commenter states that simply cannot be true because the lack of industrial activity that causes greenhouse gas emissions would pose other, almost certainly more serious health and welfare consequences.

Finally, some commenters argue that the impact of regulating under CAA section 202(a) supports making a final, negative endangerment finding. These commenters contend that the incredible costs associated with using the inflexible regulatory structure of the CAA will harm public health and welfare, and therefore EPA should exercise its discretion and find that greenhouse gases do not endanger public health and welfare because once

EPA makes an endangerment finding under CAA section 202(a), it will be forced to regulate greenhouse gases under a number of other sections of the CAA, resulting in regulatory chaos.

At their core, these comments are not about whether commenters believe greenhouse gases may reasonably be anticipated to endanger public health or welfare, but rather about commenters' dissatisfaction with the decisions that Congress made regarding the response to any endangerment finding that EPA makes under CAA section 202(a). These comments do not discuss the science of greenhouse gases or climate change, or the impacts of climate change on public health or welfare. Instead they muddle the rather straightforward scientific judgment about whether there may be endangerment by throwing the potential impact of responding to the danger into the initial question. To use an analogy, the question of whether the cure is worse than the illness is different than the question of whether there is an illness in the first place. The question of whether there is endangerment is like the question of whether there is an illness. Once one knows there is an illness, then the next question is what to do, if anything, in response to that illness.

What these comments object to is that Congress has already made some decisions about next steps after a finding of endangerment, and commenters are displeased with the results. But if this is the case, commenters should take up their concerns with Congress, not EPA. EPA's charge is to issue new motor vehicle standards under CAA section 202(a) applicable to emissions of air pollutants that cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. It is not to find that there is no endangerment in order to avoid issuing those standards, and dealing with any additional regulatory impact.

Indeed, commenters' argument would insert policy considerations into the endangerment decision, an approach already rejected by the Supreme Court. First, as discussed in Section 1.B of these Findings, in *Massachusetts v. EPA*, the court clearly indicated that the Administrator's decision must be a "scientific judgment." 549 U.S. at 534. She must base her decision about endangerment on the science, and not on policy considerations about the repercussions or impact of such a finding.

Second, in considering whether the CAA allowed for economic considerations to play a role in the promulgation of the NAAQS, the

Supreme Court rejected arguments that because many more factors than air pollution might affect public health, EPA should consider compliance costs that produce health losses in setting the NAAQS. *Whitman v. ATA*, 531 U.S. at 457, 466 (2001). To be sure, the language in CAA section 109(b) applicable to the setting of a NAAQS is different than that in CAA section 202(a) regarding endangerment. But the concepts are similar—the NAAQS are about setting standards at a level requisite to protect public health (with an adequate margin of safety) and public welfare, and endangerment is about whether the current or projected future levels may reasonably be anticipated to endanger public health or welfare. In other words, both decisions essentially are based on assessing the harm associated with a certain level of air pollution.

Given this similarity in purpose, as well as the Court's instructions in *Massachusetts v. EPA* that the Administrator should base her decision on the science, EPA reasonably interprets the statutory endangerment language to be analogous to setting the NAAQS. Therefore, it is reasonable to interpret the endangerment test as not requiring the consideration of the impacts of implementing the statute in the event of an endangerment finding as part of the endangerment finding itself.¹⁶

Moreover, EPA does not believe that the impact of regulation under the CAA as a whole, let alone that which will result from this particular endangerment finding, will lead to the panoply of adverse consequences that commentors predict. EPA has the ability to fashion a reasonable and common-sense approach to address greenhouse gas emissions and climate change. The Administrator thinks that EPA has and will continue to take a measured approach to address greenhouse gas emissions. For example, the Agency's recent Mandatory Greenhouse Gas Reporting Rule focuses on only the largest sources of greenhouse gases in order to reduce the burden on smaller facilities.¹⁷

¹⁶ Indeed, some persons may argue that due to the similarities between setting a NAAQS and making an endangerment finding, EPA cannot consider the impacts of implementation of the statute.

¹⁷ Note that it is EPA's current position that these Final Findings do not make well-mixed greenhouse gases "subject to regulation" for purposes of the CAA's Prevention of Significant Deterioration (PSD) and title V programs. See, e.g., memorandum entitled "EPA's Interpretation of Regulations that Determine Pollutants Covered By Federal Prevention of Significant Deterioration (PSD) Permit Program" (Dec. 18, 2008). While EPA is reconsidering this memorandum and is seeking

We also note that commentors' approach also is another version of the argument that EPA must consider adaptation and mitigation in the endangerment determination. Just as EPA should consider whether mitigation would *reduce* endangerment, commentors argue we should consider whether mitigation would *increase* endangerment. But as discussed previously, EPA disagrees and believes its approach better achieves the goals of the statute.

Finally, EPA simply disagrees with the commenter who argues that because we are better off now than before the industrial revolution, greenhouse gases cannot be found to endanger public health or welfare. As the DC Circuit noted in the *Ethyl* decision, "[m]an's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations." See *Ethyl Corp.*, 541 F.2d at 6. The fact that we as a society are better off now than 100 years ago, and that processes that produce greenhouse gases are a large part of this improvement, does not mean that those processes do not have unintended adverse impacts. It also was entirely reasonable for EPA to look at "emissions" as the pollution once it is emitted from the source into the air, and not also as the process that generates the pollution. Indeed, the definition of "air pollutant" talks in terms of substances "emitted into or otherwise enter[ing] the ambient air" (CAA section 302(g)). It is entirely appropriate for EPA to consider only the substance being emitted as the air pollution or air pollutant.

IV. The Administrator's Finding That Greenhouse Gases Endanger Public Health and Welfare

The Administrator finds that elevated concentrations of greenhouse gases in

public comment on the issues raised in it generally, including whether a final endangerment finding should trigger PSD, the effectiveness of the positions provided in the memorandum was not stayed pending that reconsideration. Prevention of Significant Deterioration (PSD): Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by the Federal PSD Permit Program, 74 FR 515135, 51543–44 (Oct. 7, 2009). In addition, EPA has proposed new temporary thresholds for greenhouse gas emissions that define when PSD and title V permits are required for new or existing facilities. Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule (74 FR 55292, October 27, 2009). The proposed thresholds would "tailor" the permit programs to limit which facilities would be required to obtain PSD and title V permits. As noted in the preamble for the tailoring rule proposal, EPA also intends to evaluate ways to streamline the process for identifying GHG emissions control requirements and issuing permits. See the Response to Comments Document, Volume 11, and the Tailoring Rule, for more information.

the atmosphere may reasonably be anticipated to endanger the public health and to endanger the public welfare of current and future generations. The Administrator is making this finding specifically with regard to six key directly-emitted, long-lived and well-mixed greenhouse gases: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The Administrator is making this judgment based on both current observations and projected risks and impacts into the future. Furthermore, the Administrator is basing this finding on impacts of climate change within the United States. However, the Administrator finds that when she considers the impacts on the U.S. population of risks and impacts occurring in other world regions, the case for endangerment to public health and welfare is only strengthened.

A. The Air Pollution Consists of Six Key Greenhouse Gases

The Administrator must define the scope and nature of the relevant air pollution for the endangerment finding under CAA section 202(a). In this final action, the Administrator finds that the air pollution is the combined mix of six key directly-emitted, long-lived and well-mixed greenhouse gases (henceforth "well-mixed greenhouse gases"), which together, constitute the root cause of human-induced climate change and the resulting impacts on public health and welfare. These six greenhouse gases are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

EPA received public comments on this definition of air pollution from the Proposed Findings, and summarizes responses to some of those key comments below; fuller responses to public comments can be found in EPA's Response to Comments document, Volume 9. The Administrator acknowledges that other anthropogenic climate forcers also play a role in climate change. Many public comments either supported or opposed inclusion of other substances in addition to the six greenhouse gases for the definition of air pollution. EPA's responses to those comments are also summarized below, and in volume 9 of the Response to Comments document.

The Administrator explained her rationale for defining air pollution under CAA section 202(a) as the combined mix of the six greenhouse gases in the Proposed Findings. After review of the public comments, the Administrator is using the same definition of the air pollution in the

final finding, for the following reasons: (1) These six greenhouse gas share common properties regarding their climate effects; (2) these six greenhouse gases have been estimated to be the primary cause of human-induced climate change, are the best understood drivers of climate change, and are expected to remain the key driver of future climate change; (3) these six greenhouse gases are the common focus of climate change science research and policy analyses and discussions; (4) using the combined mix of these gases as the definition (versus an individual gas-by-gas approach) is consistent with the science, because risks and impacts associated with greenhouse gas-induced climate change are not assessed on an individual gas approach; and (5) using the combined mix of these gases is consistent with past EPA practice, where separate substances from different sources, but with common properties, may be treated as a class (e.g., oxides of nitrogen).

1. Common Physical Properties of the Six Greenhouse Gases

The common physical properties relevant to the climate change problem shared by the six greenhouse gases include the fact that they are long-lived in the atmosphere. "Long-lived" is used here to mean that the gas has a lifetime in the atmosphere sufficient to become globally well mixed throughout the entire atmosphere, which requires a minimum atmospheric lifetime of about one year.¹⁹ Thus, this definition of air pollution is global in nature because the greenhouse gas emissions emitted from the United States (or from any other region of the world) become globally well mixed, such that it would not be meaningful to define the air pollution as the greenhouse gas concentrations over the United States as somehow being distinct from the greenhouse gas concentrations over other regions of the world.

It is also well established that each of these gases can exert a warming effect on the climate by trapping in heat that would otherwise escape to space. These

¹⁹ The IPCC also refers to these six GHGs as long-lived. Methane has an atmospheric lifetime of roughly a decade. One of the most commonly used hydrofluorocarbons (HFC-134a) has a lifetime of 14 years. Nitrous oxide has a lifetime of 114 years; sulfur hexafluoride over 3,000 years; and some PFCs up to 10,000 to 50,000 years. Carbon dioxide in the atmosphere is sometimes approximated as having a lifetime of roughly 100 years, but for a given amount of carbon dioxide emitted a better description is that some fraction of the atmospheric increase in concentration is quickly absorbed by the oceans and terrestrial vegetation, some fraction of the atmospheric increase will only slowly decrease over a number of years, and a small portion of the increase will remain for many centuries or more.

six gases are directly emitted as greenhouse gases rather than forming as a greenhouse gas in the atmosphere after emission of a pre-cursor gas. Given these properties, the magnitude of the warming effect of each of these gases is generally better understood than other climate forcing agents that do not share these same properties (addressed in more detail below). The ozone-depleting substances that include chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HFCs) also share the same physical attributes discussed here, but for reasons discussed throughout the remainder of this section are not being included in the Administrator's definition of air pollution for this finding.

2. Evidence That the Six Greenhouse Gases Are the Primary Driver of Current and Projected Climate Change

a. Key Observations Driven Primarily by the Six Greenhouse Gases

The latest assessment of the USGCRP, as summarized in EPA's TSD, confirms the evidence presented in the Proposed Findings that current atmospheric greenhouse gas concentrations are now at elevated and essentially unprecedented levels as a result of both historic and current anthropogenic emissions. The global atmospheric carbon dioxide concentration has increased about 38 percent from pre-industrial levels to 2009, and almost all of the increase is due to anthropogenic emissions. The global atmospheric concentration of methane has increased by 149 percent since pre-industrial levels (through 2007); and the nitrous oxide concentration has increased 23 percent (through 2007). The observed concentration increase in these gases can also be attributed primarily to anthropogenic emissions. The industrial fluorinated gases have relatively low concentrations, but these concentrations have also been increasing and are almost entirely anthropogenic in origin.

Historic data show that current atmospheric concentrations of the two most important directly emitted, long-lived greenhouse gases (carbon dioxide and methane) are well above the natural range of atmospheric concentrations compared to at least the last 650,000 years. Atmospheric greenhouse gas concentrations have been increasing because anthropogenic emissions are outpacing the rate at which greenhouse gases are removed from the atmosphere by natural processes over timescales of decades to centuries. It also remains clear that these high atmospheric concentrations of greenhouse gases are

the unambiguous result of human activities.

Together the six well-mixed greenhouse gases constitute the largest anthropogenic driver of climate change.¹⁹ Of the total anthropogenic heating effect caused by the accumulation of the six well-mixed greenhouse gases plus other warming agents (that do not meet all of the Administrator's criteria that pertain to the six greenhouse gases) since pre-industrial times, the combined heating effect of the six well-mixed greenhouse gases is responsible for roughly 75 percent, and it is expected that this share may grow larger over time, as discussed below.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Global mean surface temperatures have risen by 0.74 °C (1.3 °F) (±0.18 °C) over the last 100 years. Eight of the 10 warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.

The global surface temperature record relies on three major global temperature datasets, developed by NOAA, NASA, and the United Kingdom's Hadley Center. All three show an unambiguous warming trend over the last 100 years, with the greatest warming occurring over the past 30 years.²⁰ Furthermore, all three datasets show that eight of the 10 warmest years on record have occurred since 2001; that the 10 warmest years have all occurred in the past 12 years; and that the 20 warmest years have all occurred since 1981. Though most of the warmest years on record have occurred in the last decade in all available datasets, the rate of warming has, for a short time in the

¹⁹ As summarized in EPA's TSD, the global average net effect of the increase in atmospheric greenhouse gas concentrations, plus other human activities (e.g., land use change and aerosol emissions), on the global energy balance since 1750 has been one of warming. This total net heating effect, referred to as forcing, is estimated to be +1.6 (+0.6 to +2.4) Watts per square meter (W/m²), with much of the range surrounding this estimate due to uncertainties about the cooling and warming effects of aerosols. The combined radiative forcing due to the cumulative (i.e., 1750 to 2005) increase in atmospheric concentrations of CO₂, CH₄, and N₂O is estimated to be +2.30 (+2.07 to +2.53) W/m². The rate of increase in positive radiative forcing due to these three GHGs during the industrial era is very likely to have been unprecedented in more than 10,000 years.

²⁰ See section 4 of the TSD for more detailed information about the three global temperature datasets.

Hadley Center record, slowed. However, the NOAA and NASA trends do not show the same marked slowdown for the 1999–2008 period. Year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend. Thus, each year may not necessarily be warmer than every year before it, though the long-term warming trend continues.²¹

The scientific evidence is compelling that elevated concentrations of heat-trapping greenhouse gases are the root cause of recently observed climate change. The IPCC conclusion from 2007 has been re-confirmed by the June 2009 USGCRP assessment that most of the observed increase in global average temperatures since the mid-20th century is very likely²² due to the observed increase in anthropogenic greenhouse gas concentrations. Climate model simulations suggest natural forcing alone (e.g., changes in solar irradiance) cannot explain the observed warming.

The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual.²³ The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic).

The claim that natural internal variability or known natural external

forcings can explain most (more than half) of the observed global warming of the past 50 years is inconsistent with the vast majority of the scientific literature, which has been synthesized in several assessment reports. Based on analyses of widespread temperature increases throughout the climate system and changes in other climate variables, the IPCC has reached the following conclusions about external climate forcing: "It is extremely unlikely (<5 percent) that the global pattern of warming during the past half century can be explained without external forcing, and very unlikely that it is due to known natural external causes alone" (Hegerl *et al.*, 2007). With respect to internal variability, the IPCC reports the following: "The simultaneous increase in energy content of all the major components of the climate system as well as the magnitude and pattern of warming within and across the different components supports the conclusion that the cause of the [20th century] warming is extremely unlikely (<5 percent) to be the result of internal processes" (Hegerl *et al.*, 2007). As noted in the TSD, the observed warming can only be reproduced with models that contain both natural and anthropogenic forcings, and the warming of the past half century has taken place at a time when known natural forcing factors alone (solar activity and volcanoes) would likely have produced cooling, not warming.

United States temperatures also warmed during the 20th and into the 21st century; temperatures are now approximately 0.7 °C (1.3 °F) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC and CCSP reports attributed recent North American warming to elevated greenhouse gas concentrations. The CCSP (2008g) report finds that for North America, "more than half of this warming [for the period 1951–2006] is likely the result of human-caused greenhouse gas forcing of climate change."

Observations show that changes are occurring in the amount, intensity, frequency, and type of precipitation. Over the contiguous United States, total annual precipitation increased by 6.1 percent from 1901–2008. It is likely that there have been increases in the number of heavy precipitation events within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate.

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an

increased rate. It is very likely that the response to anthropogenic forcing contributed to sea level rise during the latter half of the 20th century. It is not clear whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend. Nearly all of the Atlantic Ocean shows sea level rise during the last 50 years with the rate of rise reaching a maximum (over 2 mm per year) in a band along the U.S. east coast running east-northeast.

Satellite data since 1979 show that annual average Arctic sea ice extent has shrunk by 4.1 percent per decade. The size and speed of recent Arctic summer sea ice loss is highly anomalous relative to the previous few thousands of years.

Widespread changes in extreme temperatures have been observed in the last 50 years across all world regions including the United States. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. However, directly attributing specific regional changes in climate to emissions of greenhouse gases from human activities is difficult, especially for precipitation.

Ocean carbon dioxide uptake has lowered the average ocean pH (increased the acidity) level by approximately 0.1 since 1750. Consequences for marine ecosystems may include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments.

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. The consistency of these observed changes in physical and biological systems and the observed significant warming likely cannot be explained entirely due to natural variability or other confounding non-climate factors.

b. Key Projections Based Primarily on Future Scenarios of the Six Greenhouse Gases

There continues to be no reason to expect that, without substantial and near-term efforts to significantly reduce emissions, atmospheric levels of greenhouse gases will not continue to climb, and thus lead to ever greater rates of climate change. Given the long atmospheric lifetime of the six greenhouse gases, which range from roughly a decade to centuries, future atmospheric greenhouse gas

²¹ Karl *T. et al.* (2009).

²² The IPCC Fourth Assessment Report uses specific terminology to convey likelihood and confidence. Likelihood refers to a probability that the statement is correct or that something will occur. "Virtually certain" conveys greater than 99 percent probability of occurrence; "very likely" 90 to 99 percent; "likely" 66 to 90 percent. IPCC assigns confidence levels as to the correctness of a statement. "Very high confidence" conveys at least 9 out of 10 chance of being correct; "high confidence" about 8 out of 10 chance; "medium confidence" about 5 out of 10 chance. The USGCRP uses the same or similar terminology in its reports. See also Box 1.2 of the TSD. Throughout this document, this terminology is used in conjunction with statements from the IPCC and USGCRP reports to convey the same meaning that those reports intended. In instances where a word such as "likely" may appear outside the context of a specific IPCC or USGCRP statement, it is not meant to necessarily convey the same quantitative meaning as the IPCC terminology.

²³ Karl *T. et al.* (2009).

concentrations for the remainder of this century and beyond will be influenced not only by future emissions but indeed by present-day and near-term emissions. Consideration of future plausible scenarios, and how our current greenhouse gas emissions essentially commit present and future generations to cope with an altered atmosphere and climate, reinforces the Administrator's judgment that it is appropriate to define the combination of the six key greenhouse gases as the air pollution.

Most future scenarios that assume no explicit greenhouse gas mitigation actions (beyond those already enacted) project increasing global greenhouse gas emissions over the century, which in turn result in climbing greenhouse gas concentrations. Under the range of future emission scenarios evaluated by the assessment literature, carbon dioxide is expected to remain the dominant anthropogenic greenhouse gas, and thus driver of climate change, over the course of the 21st century. In fact, carbon dioxide is projected to be the largest contributor to total radiative forcing in all periods and the radiative forcing associated with carbon dioxide is projected to be the fastest growing. For the year 2030, projections of the six greenhouse gases show an increase of 25 to 90 percent compared with 2000 emissions. Concentrations of carbon dioxide and the other well-mixed gases increase even for those scenarios where annual emissions toward the end of the century are assumed to be lower than current annual emissions. The radiative forcing associated with the non-carbon dioxide well-mixed greenhouse gases is still important and increasing over time. Emissions of the ozone-depleting substances are projected to continue decreasing due to the phase-out schedule under the Montreal Protocol on Substances that Deplete the Ozone Layer. Considerable uncertainties surround the estimates and future projections of anthropogenic aerosols; future atmospheric concentrations of aerosols, and thus their respective heating or cooling effects, will depend much more on assumptions about future emissions because of their short atmospheric lifetimes compared to the six well-mixed greenhouse gases.

Future warming over the course of the 21st century, even under scenarios of low emissions growth, is very likely to be greater than observed warming over the past century. According to climate model simulations summarized by the IPCC, through about 2030, the global warming rate is affected little by the choice of different future emission scenarios. By the end of the century, projected average global warming

(compared to average temperature around 1990) varies significantly depending on emissions scenario and climate sensitivity assumptions, ranging from 1.8 to 4.0 °C (3.2 to 7.2 °F), with an uncertainty range of 1.1 to 6.4 °C (2.0 to 11.5 °F).

All of the United States is very likely to warm during this century, and most areas of the United States are expected to warm by more than the global average. The largest warming is projected to occur in winter over northern parts of Alaska. In western, central and eastern regions of North America, the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans.

3. The Six Greenhouse Gases Are Currently the Common Focus of the Climate Change Science and Policy Communities

The well-mixed greenhouse gases are currently the common focus of climate science and policy analyses and discussions. For example, the United Nations Framework Convention on Climate Change (UNFCCC), signed and ratified by the United States in 1992, requires its signatories to "develop, periodically update, publish and make available * * * national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies * * *"^{24 25} To date, the focus of UNFCCC actions and discussions has been on the six greenhouse gases that are the same focus of these Findings.

Because of these common properties, it has also become common practice to compare these gases on a carbon dioxide equivalent basis, based on each gas's warming effect relative to carbon dioxide (the designated reference gas) over a specified timeframe. For example, both the annual *Inventory of U.S. Greenhouse Gases and Sinks* published by EPA and the recently finalized EPA Mandatory Greenhouse Gas Reporting Rule (74 FR 56260), use the carbon dioxide equivalent metric to

²⁴ Due to the cumulative purpose of the statutory language, even if the Administrator were to look at the atmospheric concentration of each greenhouse gas individually, she would still consider the impact of the concentration of a single greenhouse gas in combination with that caused by the other greenhouse gases.

²⁵ The range of uncertainty in the current magnitude of black carbon's climate forcing effect is evidenced by the ranges presented by the IPCC Fourth Assessment Report (2007) and the more recent study by Ramanathan, V. and Carmichael, G. (2008) Global and regional climate changes due to black carbon. *Nature Geoscience*, 1(4): 221–227.

sum and compare these gases, and thus accept the common climate-relevant properties of these gases for their treatment as a group. This is also common practice internationally as the UNFCCC reporting guidelines for developed countries, and the Clean Development Mechanism procedures for developing countries both require the use of global warming potentials published by the IPCC to convert the six greenhouse gases into their respective carbon dioxide equivalent units.

4. Defining Air Pollution as the Aggregate Group of Six Greenhouse Gases Is Consistent With Evaluation of Risks and Impacts Due to Human-Induced Climate Change

Because the well-mixed greenhouse gases are collectively the primary driver of current and projected human-induced climate change, all current and future risks due to human-induced climate change—whether these risks are associated with increases in temperature, changes in precipitation, a rise in sea levels, changes in the frequency and intensity of weather events, or more directly with the elevated greenhouse gas concentrations themselves—can be associated with this definition of air pollution.

5. Defining the Air Pollution as the Aggregate Group of Six Greenhouse Gases Is Consistent With Past EPA Practice

Treating the air pollution as the aggregate of the well-mixed greenhouse gases is consistent with other provisions of the CAA and previous EPA practice under the CAA, where separate emissions from different sources but with common properties may be treated as a class (e.g., particulate matter (PM)). This approach addresses the total, cumulative effect that the elevated concentrations of the six well-mixed greenhouse gases have on climate, and thus on different elements of health, society and the environment.²⁴

EPA treats, for example, PM as a common class of air pollution; PM is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

6. Other Climate Forcers Not Being Included in the Definition of Air Pollution for This Finding

Though the well-mixed greenhouse gases that make up the definition of air pollution for purposes of making the endangerment decision under CAA section 202(a) constitute the primary

driver of human-induced climate change, there are other substances emitted from human activities that contribute to climate change and deserve careful attention, but are not being included in the air pollution definition for this particular action. These substances are discussed immediately below.

a. Black Carbon

Several commenters request that black carbon be included in the definition of air pollution because of its warming effect on the climate. Black carbon is not a greenhouse gas, rather, it is an aerosol particle that results from the incomplete combustion of carbon contained in fossil fuels and biomass, and remains in the atmosphere for only about a week. Unlike any of the greenhouse gases being addressed by this action, black carbon is a component of particulate matter (PM), where PM is a criteria air pollutant under section 108 of the CAA. The extent to which black carbon makes up total PM varies by emission source, where, for example, diesel vehicle PM emissions contain a higher fraction of black carbon compared to most other PM emission sources. Black carbon causes a warming effect primarily by absorbing incoming and reflected sunlight (whereas greenhouse gases cause warming by trapping outgoing, infrared heat), and by darkening bright surfaces such as snow and ice, which reduces reflectivity. This latter effect, in particular, has been raising concerns about the role black carbon may be playing in observed warming and ice melt in the Arctic.

As stated in the April 2009 Proposed Findings, there remain some significant scientific uncertainties about black carbon's total climate effect,²⁶ as well as concerns about how to treat the short-lived black carbon emissions alongside the long-lived, well-mixed greenhouse gases in a common framework (e.g., what are the appropriate metrics to compare the warming and/or climate effects of the different substances, given that, unlike greenhouse gases, the magnitude of aerosol effects can vary immensely with location and season of emissions). Nevertheless, the Administrator recognizes that black carbon is an important climate forcing agent and takes very seriously the emerging science on black carbon's contribution to global climate change in general and the high rates of observed climate change in the Arctic in particular. As noted in the Proposed Findings, EPA has various pending petitions under the CAA calling on the Agency to make an endangerment

finding and regulate black carbon emissions.

b. Other Climate Forcers

There are other climate forcers that play a role in human-induced climate change that were mentioned in the Proposed Findings, and were the subject of some public comments. These include the stratospheric ozone-depleting substances, nitrogen trifluoride (NF₃), water vapor, and tropospheric ozone.

As mentioned above, the ozone-depleting substances (CFCs and HCFCs) do share the same physical, climate-relevant attributes as the six well-mixed greenhouse gases; however, emissions of these substances are playing a diminishing role in human-induced climate change. They are being controlled and phased out under the Montreal Protocol on Substances that Deplete the Ozone Layer. Because of this, the major scientific assessment reports such as those from IPCC focus primarily on the same six well-mixed greenhouse gases included in the definition of air pollution in these Findings. It is also worth noting that the UNFCCC, to which the United States is a signatory, addresses "all greenhouse gases not controlled by the Montreal Protocol."²⁶ One commenter noted that because the Montreal Protocol controls production and consumption of ozone-depleting substances, but not existing banks of the substances, that CFCs should be included in the definition of air pollution in this finding, which might, in turn, create some future action under the CAA to address the banks of ozone-depleting substances as a climate issue. However, the primary criteria for defining the air pollution in this finding is the focus on the core of the climate change problem, and concerns over future actions to control depletion of stratospheric ozone are separate from and not central to the air pollution causing climate change.

Nitrogen trifluoride also shares the same climate-relevant attributes as the six well-mixed greenhouse gases, and it is also included in EPA's Mandatory Greenhouse Gas Reporting Rule (FR 74 56260). However, the Administrator is maintaining the reasoning laid out in the Proposed Findings to not include NF₃ in the definition of air pollution for this finding because the overall magnitude of its forcing effect on climate is not yet well quantified. EPA will continue to track the science on NF₃.

A number of public comments question the exclusion of water vapor

from the definition of air pollution because it is the most important greenhouse gas responsible for the natural, background greenhouse effect. The Administrator's reasoning for excluding water vapor, was described in the Proposed Findings and is summarized here with additional information in Volume 10 of the Response to Comments document. First, climate change is being driven by the buildup in the atmosphere of greenhouse gases. The direct emissions primarily responsible for this are the six well-mixed greenhouse gases. Direct anthropogenic emissions of water vapor, in general, have a negligible effect and are thus not considered a primary driver of human-induced climate change. EPA plans to further evaluate the issues of emissions of water that are implicated in the formation of contrails and also changes in water vapor due to local irrigation. At this time, however, the findings of the IPCC state that the total forcing from these sources is small and that the level of understanding is low.

Water produced as a byproduct of combustion at low altitudes has a negligible contribution to climate change. The residence time of water vapor is very short (days) and the water content of the air in the long term is a function of temperature and partial pressure, with emissions playing no role. Additionally, the radiative forcing of a given mass of water at low altitudes is much less than the same mass of carbon dioxide. Water produced at higher altitudes could potentially have a larger impact. The IPCC estimated the contribution of changes in stratospheric water vapor due to methane and other sources, as well as high altitude contributions from contrails, but concluded that both contributions were small, with a low level of understanding. The report also addressed anthropogenic contributions to water vapor arising from large scale irrigation, but assigned it a very low level of understanding, and suggested that the cooling from evaporation might outweigh the warming from its small radiative contribution.

Increases in tropospheric ozone concentrations have exerted a significant anthropogenic warming effect since pre-industrial times. However, as explained in the Proposed Findings, tropospheric ozone is not a long-lived, well-mixed greenhouse gas, and it is not directly emitted. Rather it forms in the atmosphere from emissions of pre-cursor gases. There is increasing attention in climate change research and the policy community about the extent to which further reductions in tropospheric ozone levels may help

²⁶ UNFCCC, Art. 4.1(b).

slow down climate change in the near term. The Administrator views this issue seriously but maintains that tropospheric ozone is sufficiently different such that it deserves an evaluation and treatment separate from this finding.

7. Summary of Key Comments on Definition of Air Pollution

a. It Is Reasonable for the Administrator To Define the Air Pollution as Global Concentrations of the Well-Mixed Greenhouse Gases

Many commenters argue that EPA does not have the authority to establish domestic rights and obligations based on environmental conditions that are largely attributed to foreign nations and entities that are outside the jurisdiction of EPA under the CAA. They contend that in this case, the bulk of emissions that would lead to mandatory emissions controls under the CAA would not and could not be regulated under the CAA. They state that CAA requirements cannot be enforced against foreign sources of air pollution, and likewise domestic obligations under the CAA cannot be caused by foreign emissions that are outside the United States. The commenters argue that EPA committed procedural error by not addressing this legal issue of authority in the proposal.

Commenters cite no statutory text or judicial authority for this argument, and instead rely entirely on an analogy to the issues concerning the exercise of extra-territorial jurisdiction. The text of CAA section 202(a), however, does not support this claim. Nothing in CAA section 202(a) limits the term air pollution to those air pollution matters that are caused solely or in large part by domestic emissions. The only issue under CAA section 202(a) is whether the air pollution is reasonably anticipated to endanger, and whether emissions from one domestic source category—new motor vehicles—cause or contribute to this air pollution. Commenters would read into this an additional cause or contribute test—whether foreign sources cause or contribute to the air pollution in such a way that the air pollution is largely attributable to the foreign emissions, or the bulk of emissions causing the air pollution are from foreign sources. There is no such provision in CAA section 202(a). Congress was explicit about the contribution test it imposed, and the only source that is relevant for purposes of contribution is new motor vehicles. Commenters suggest an ill-defined criterion that is not in the statute.

In addition, as discussed in Section II of these Findings, Congress intentionally meant the agency to judge the air pollution endangerment criteria based on the “cumulative impact of all sources of a pollutant,” and not an incremental look at just the endangerment from a subset of sources. Commenters’ arguments appear to lead to this result. Under the commenters’ approach, in those cases where the bulk of emissions which form the air pollution come from foreign sources, EPA apparently would have no authority to make an endangerment finding. Logically, EPA would be left with the option of identifying and evaluating the air pollution attributable to domestic sources alone, and determining whether that narrowly defined form of air pollution endangers public health or welfare. This is the kind of unworkable, incremental approach that was rejected by the court in *Ethyl* and by Congress in the 1977 amendments adopting this provision.

The analogy to extra-territorial jurisdiction is also not appropriate. The endangerment finding itself does not exercise jurisdiction over any source, domestic or foreign. It is a judgment that is a precondition for exercising regulatory authority. Under CAA section 202(a), any exercise of regulatory authority following from this endangerment finding would be for new motor vehicles either manufactured in the United States or imported into the United States. There would be no extra-territorial exercise of jurisdiction. The core issues for endangerment focus on impacts inside the United States, not outside the United States. In addition, the contribution finding is based solely on the contribution from new motor vehicles built in or imported to the United States. The core judgments that need to be made under CAA section 202(a) are all focused on actions and impacts inside the United States. This does not raise any concerns about an extra-territorial exercise of jurisdiction. The basis for the endangerment and contribution findings is fully consistent with the principles underlying the desire to avoid exercises of extra-territorial jurisdiction. Any limitations on the ability to exercise control over foreign sources of emissions does not, however, call into question the authority under CAA section 202 to exercise control over domestic sources of emissions based on their contribution to an air pollution problem that is judged to endanger public health or welfare based on impacts occurring in the United States or otherwise affecting the United States and its citizens.

In essence, commenters are concerned about the effectiveness of the domestic control strategies that can be adopted to address a global air pollution problem that is caused only in part by domestic sources of emissions. While that is a quite valid and important policy concern, it does not translate into a legal limitation on EPA’s authority to make an endangerment finding. Neither the text nor the legislative history of CAA section 202(a) support such an interpretation and Congress explicitly separated the decision on endangerment from the decision on what controls are required or appropriate once an affirmative endangerment finding has been made. The effectiveness of the resulting regulatory controls is not a relevant factor to determining endangerment.

EPA also committed no procedural flaw as argued by commenters. The proposal fully explored the interpretation of endangerment and cause or contribution under CAA section 202(a), and was very clear that EPA was considering air pollution to mean the elevated global concentration of greenhouse gases in the atmosphere, recognizing that these atmospheric concentrations were the result of world wide emissions, not just or even largely U.S. emissions. The separation of the effectiveness of the control strategy from the endangerment criteria, and the need to consider the cumulative impact of all sources in evaluating endangerment was clearly discussed. Commenters received fair notice of EPA’s proposal and the basis for it.

Similarly, some commenters argue that EPA’s proposal defines air pollution as global air pollution, but EPA is limited to evaluating domestic air only; in other words that EPA may only regulate domestic emissions with localized effects. They argue this limitation derives from the purpose of the CAA—to enhance the quality of the Nation’s air resources, recognizing that air pollution prevention and control focus on the sources of the emissions, and are the primary responsibility of States and local governments. Therefore, commenters continue, that “air pollution” has to be air pollution that originates domestically and is to be addressed only at the domestic source. Sections 115 and 179B of the CAA, as discussed below, reflect this intention as well. The result, they conclude, is that “air pollution” as used in CAA section 202(a), includes only pollution that originates domestically, where the effects occur locally. They argue EPA has improperly circumvented this by a “local-global-local” analysis that injects

global air pollution into the middle of the endangerment test.

The statutory arguments made by the commenters attempt to read an unrealistic limitation into the general provisions discussed. The issues are similar in nature to those raised by the commenters arguing that EPA has no authority to establish domestic rights and obligations based on environmental conditions that are largely attributable to emissions from foreign nations and entities that are outside the jurisdiction of EPA under the CAA. In both cases, the question is whether EPA has authority to make an endangerment finding when the air pollution of concern is a relatively homogenous atmospheric concentration of greenhouse gases. According to the commenters, although this global pool includes the air over the United States, and leads to impacts in the United States and on the U.S. population, Congress prohibited EPA from addressing this air pollution problem because of its global aspects.

The text of the CAA does not specifically address this, as the term air pollution is not defined. EPA interprets this term as including the air pollution problem involved in this case—elevated atmospheric concentration of greenhouse gases that occur in the air above the United States as well as across the globe, and where this pool of global gases leads to impacts in the United States and on the U.S. population. This is fully consistent with the statutory provisions discussed by commenters. This approach seeks to protect the Nation's air resources, as clearly the Nation's air resources are an integral part of this global pool. The Nation's air resources by definition are not an isolated atmosphere that only contains molecules emitted within the United States, or an atmosphere that bears no relationship to the rest of the globe's atmosphere. There is no such real world body of air. Protecting the Nation's resources of clean air means to protect the air in the real world, not an artificial construct of "air" that ignores the many situations where the air over our borders includes compounds and pollutants emitted outside our borders, and in this case to ignore the fact that the air over our borders will by definition have elevated concentrations of greenhouse gases only when the air around the globe also has such concentrations. The suggested narrow view of "air pollution" does not further the protection of the Nation's air resources, but instead attempts to limit such protection by defining these resources in a scientifically artificial way that does not comport with how the air in

the atmosphere is formed or changes over time, how it relates to and interacts with air around the globe, and how the result of this can affect the U.S. population.

The approach suggested by commenters fails to provide an actual definition for EPA to follow—for example, would U.S. or domestic "air pollution" be limited to only those air concentrations composed of molecules that originated in the United States? Is there a degree of external gases or compounds that could be allowed? Would it ignore the interaction and relationship between the air over the U.S. borders and the air around the rest of the globe? The latter approach appears to be the one suggested by commenters. Commenters' approach presumably would call for EPA to only consider the effects that derive solely from the air over our borders, and to ignore any effects that occur within the United States that are caused by air around the globe. However the air over the United States will by definition affect climate change only in circumstances where the air around the world is also doing so. The impacts of the air over the United States cannot be assessed separately from the impacts from the global pool, as they occur together and work together to affect the climate. Ignoring the real world nature of the Nation's air resources, in the manner presumably suggested by the commenters, would involve the kind of unworkable, incremental, and artificially isolating approach that was rejected by the court in *Ethyl* and by Congress in 1977. Congress intended EPA to interpret this provision by looking at air pollutants and air pollution problems in a broad manner, not narrowly, to evaluate problems within their broader context and not to attempt to isolate matters in an artificial way that fails to account for the real world context that lead to health and welfare impacts on the public. Commenters' suggested interpretation fails to implement this intention of Congress.

Commenters in various places refer to the control of the pollution, and the need for it to be aimed at local sources. That is addressed in the standard setting portion of CAA section 202(a), as in other similar provisions. The endangerment provision does not address how the air pollution problem should be addressed—who should be regulated and how they should be regulated. The endangerment provision addresses a different issue—is there an air pollution problem that should be addressed? In that context, EPA rejects the artificially narrow interpretation

suggested by the commenters, and believes its broader interpretation in this case is reasonable and consistent with the intention of Congress.

b. Consideration of Greenhouse Gases as Air Pollution Given Their Impact Is Through Climate Rather Than Direct Toxic Effects

A number of commenters argue that carbon dioxide and the other greenhouse gases should not be defined as the air pollution because these gases do not cause direct human health effects, such as through inhalation. Responses to such comments are summarized in Section IV.B.1 of these Findings in the discussion of the public health and welfare nature of the endangerment finding.

c. The Administrator's Reliance on the Global Temperature Data Is a Reasonable Indicator of Human-Induced Climate Change

We received many comments suggesting global temperatures have stopped warming. The commenters base this conclusion on temperature trends over only the last decade. While there have not been strong trends over the last seven to ten years in global surface temperature or lower troposphere temperatures measured by satellites, this pause in warming should not be interpreted as a sign that the Earth is cooling or that the science supporting continued warming is in error. Year-to-year variability in natural weather and climate patterns make it impossible to draw any conclusions about whether the climate system is warming or cooling from such a limited analysis. Historical data indicate short-term trends in long-term time series occasionally run counter to the overall trend. All three major global surface temperature records show a continuation of long-term warming. Over the last century, the global average temperature has warmed at the rate of about 0.13 °F (0.072 °C) per decade in all three records. Over the last 30 years, the global average surface temperature has warmed by about 0.30 °F (0.17 °C) per decade. Eight of the 10 warmest years on record have occurred since 2001 and the 20 warmest years have all occurred since 1981. Satellite measurements of the troposphere also indicate warming over the last 30 years at a rate of 0.20 to 0.27 °F (0.11 °C to 0.15 °C) per decade. Please see the relevant volume of the Response to Comments document for more detailed responses.

Some commenters indicate the global surface temperature records are biased by urbanization, poor siting of instruments, observation methods, and

other factors. Our review of the literature suggests that these biases have in many cases been corrected for, are largely random where they remain, and therefore cancel out over large regions. Furthermore, we note that though the three global surface temperature records use differing techniques to analyze much of the same data, they produce almost the same results, increasing our confidence in their legitimacy. The assessment literature has concluded that warming of the climate system is unequivocal. The warming trend that is evident in all of the temperature records is confirmed by other independent observations, such as the melting of Arctic sea ice, the retreat of mountain glaciers on every continent, reductions in the extent of snow cover, earlier blooming of plants in the spring, and increased melting of the Greenland and Antarctic ice sheets. Please see the relevant volume of the Response to Comments document for more detailed responses.

A number of commenters argue that the warmth of the late 20th century is not unusual relative to the past 1,000 years. They maintain temperatures were comparably warm during the Medieval Warm Period (MWP) centered around 1000 A.D. We agree there was a Medieval Warm Period in many regions but find the evidence is insufficient to assess whether it was globally coherent. Our review of the available evidence suggests that Northern Hemisphere temperatures in the MWP were probably between 0.1 °C and 0.2 °C below the 1961–1990 mean and significantly below the level shown by instrumental data after 1980. However, we note significant uncertainty in the temperature record prior to 1600 A.D. Please see the relevant volume of the Response to Comments document for more detailed responses.

d. Ability To Attribute Observed Climate Change to Anthropogenic, Well-Mixed Greenhouse Gases

Many commenters question the link between observed temperatures and anthropogenic greenhouse gas emissions. They suggest internal variability of the climate system and natural forcings explain observed temperature trends and that anthropogenic greenhouse gases play, at most, a minor role. However, the attribution of most of the recent warming to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from our basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors, and other human impacts on the climate

system. Greenhouse gas concentrations have indisputably increased and their radiative properties are well established. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual. The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic). These models are unable to replicate the observed warming unless anthropogenic emissions of greenhouse gases are included in the simulations. Natural forcing alone cannot explain the observed warming. In fact, the assessment literature²⁷ indicates the sum of solar and volcanic forcing in the past half century would likely have produced cooling, not warming. Please see the relevant volume of the Response to Comments for more detailed responses.

B. The Air Pollution Is Reasonably Anticipated To Endanger Both Public Health and Welfare

The Administrator finds that the elevated atmospheric concentrations of the well-mixed greenhouse gases may reasonably be anticipated to endanger the public health and welfare of current and future generations. This section describes the major pieces of scientific evidence supporting the Administrator's endangerment finding, discusses both the public health and welfare nature of the endangerment finding, and addresses a number of key issues the Administrator considered when evaluating the state of the science as well as key public comments on the Proposed Findings. Additional detail can be found in the TSD and the Response to Comments document.

As described in Section II of these Findings, the endangerment test under CAA section 202(a) does not require the Administrator to identify a bright line, quantitative threshold above which a

positive endangerment finding can be made. The statutory language explicitly calls upon the Administrator to use her judgment. This section describes the general approach used by the Administrator in reaching the judgment that a positive endangerment finding should be made, as well as the specific rationale for finding that the greenhouse gas air pollution may reasonably be anticipated to endanger both public health and welfare.

First, the Administrator finds the scientific evidence linking human emissions and resulting elevated atmospheric concentrations of the six well-mixed greenhouse gases to observed global and regional temperature increases and other climate changes to be sufficiently robust and compelling. This evidence is briefly explained in more detail in Section V of these Findings. The Administrator recognizes that the climate change associated with elevated atmospheric concentrations of carbon dioxide and the other well-mixed greenhouse gases have the potential to affect essentially every aspect of human health, society and the natural environment. The Administrator is therefore not limiting her consideration of potential risks and impacts associated with human emissions of greenhouse gases to any one particular element of human health, sector of the economy, region of the country, or to any one particular aspect of the natural environment. Rather, the Administrator is basing her finding on the total weight of scientific evidence, and what the science has to say regarding the nature and potential magnitude of the risks and impacts across all climate-sensitive elements of public health and welfare, now and projected out into the foreseeable future.

The Administrator has considered the state of the science on how human emissions and the resulting elevated atmospheric concentrations of well-mixed greenhouse gases may affect each of the major risk categories, *i.e.*, those that are described in the TSD, which include human health, air quality, food production and agriculture, forestry, water resources, sea level rise and coastal areas, the energy sector, infrastructure and settlements, and ecosystems and wildlife. The Administrator understands that the nature and potential severity of impacts can vary across these different elements of public health and welfare, and that they can vary by region, as well as over time.

The Administrator is therefore aware that, because human-induced climate change has the potential to be far-reaching and multi-dimensional, not all

²⁷ Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Bertsem, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.G. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jonzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramanamany, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt (2007) Technical Summary. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Karl, T. et al. (2009).

risks and potential impacts can be characterized with a uniform level of quantification or understanding, nor can they be characterized with uniform metrics. Given this variety in not only the nature and potential magnitude of risks and impacts, but also in our ability to characterize, quantify and project into the future such impacts, the Administrator must use her judgment to weigh the threat in each of the risk categories, weigh the potential benefits where relevant, and ultimately judge whether these risks and benefits, when viewed in total, are judged to be endangerment to public health and/or welfare.

This has a number of implications for the Administrator's approach in assessing the nature and magnitude of risk and impacts across each of the risk categories. First, the Administrator has not established a specific threshold metric for each category of risk and impacts. Also, the Administrator is not necessarily placing the greatest weight on those risks and impacts which have been the subject of the most study or quantification.

Part of the variation in risks and impacts is the fact that climbing atmospheric concentrations of greenhouse gases and associated temperature increases can bring about some potential benefits to public health and welfare in addition to adverse risks. The current understanding of any potential benefits associated with human-induced climate change is described in the TSD and is taken into consideration here. The potential for both adverse and beneficial effects are considered, as well as the relative magnitude of such effects, to the extent that the relative magnitudes can be quantified or characterized. Furthermore, given the multiple ways in which the buildup of atmospheric greenhouse gases can cause effects (e.g., via elevated carbon dioxide concentrations, via temperature increases, via precipitation increases, via sea level rise, and via changes in extreme events), these multiple pathways are considered. For example, elevated carbon dioxide concentrations may be beneficial to crop yields, but changes in temperature and precipitation may be adverse and must also be considered. Likewise, modest temperature increases may have some public health benefits as well as harms, and other pathways such as changes in air quality and extreme events must also be considered.

The Administrator has balanced and weighed the varying risks and effects for each sector. She has judged whether there is a pattern across the sector that

supports or does not support an endangerment finding, and if so whether the support is of more or less weight. In cases where there is both a potential for benefits and risks of harm, the Administrator has balanced these factors by determining whether there appears to be any directional trend in the overall evidence that would support placing more weight on one than the other, taking into consideration all that is known about the likelihood of the various risks and effects and their seriousness. In all of these cases, the judgment is largely qualitative in nature, and is not reducible to precise metrics or quantification.

Regarding the timeframe for the endangerment test, it is the Administrator's view that both current and future conditions must be considered. The Administrator is thus taking the view that the endangerment period of analysis extend from the current time to the next several decades, and in some cases to the end of this century. This consideration is also consistent with the timeframes used in the underlying scientific assessments. The future timeframe under consideration is consistent with the atmospheric lifetime and climate effects of the six well-mixed greenhouse gases, and also with our ability to make reasonable and plausible projections of future conditions.

The Administrator acknowledges that some aspects of climate change science and the projected impacts are more certain than others. Our state of knowledge is strongest for recently observed, large-scale changes. Uncertainty tends to increase in characterizing changes at smaller (regional) scales relative to large (global) scales. Uncertainty also increases as the temporal scales move away from present, either backward, but more importantly forward in time. Nonetheless, the current state of knowledge of observed and past climate changes and their causes enables projections of plausible future changes under different scenarios of anthropogenic forcing for a range of spatial and temporal scales.

In some cases, where the level of sensitivity to climate of a particular sector has been extensively studied, future impacts can be quantified whereas in other instances only a qualitative description of a directional change, if that, may be possible. The inherent uncertainty in the direction, magnitude, and/or rate of certain future climate change impacts opens up the possibility that some changes could be more or less severe than expected, and the possibility of unanticipated

outcomes. In some cases, low probability, high impact outcomes (*i.e.*, known unknowns) are possibilities but cannot be explicitly assessed.

1. The Air Pollution Is Reasonably Anticipated To Endanger Public Health

The Administrator finds that the well-mixed greenhouse gas air pollution is reasonably anticipated to endanger public health, for both current and future generations. The Administrator finds that the public health of current generations is endangered and that the threat to public health for both current and future generations will likely mount over time as greenhouse gases continue to accumulate in the atmosphere and result in ever greater rates of climate change.

After review of public comments, the Administrator continues to believe that climate change can increase the risk of morbidity and mortality and that these public health impacts can and should be considered when determining endangerment to public health under CAA section 202(a). As described in Section IV.B.1 of these Findings, the Administrator is not limited to only considering whether there are any direct health effects such as respiratory or toxic effects associated with exposure to greenhouse gases.

In making this public health finding, the Administrator considered direct temperature effects, air quality effects, the potential for changes in vector-borne diseases, and the potential for changes in the severity and frequency of extreme weather events. In addition, the Administrator considered whether and how susceptible populations may be particularly at risk. The current state of science on these effects from the major assessment reports is described in greater detail in the TSD, and our responses to public comments are provided in the Response to Comments Documents.

a. Direct Temperature Effects

It has been estimated that unusually hot days and heat waves are becoming more frequent, and that unusually cold days are becoming less frequent, as noted above. Heat is already the leading cause of weather-related deaths in the United States. In the future, severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur. Heat waves are associated with marked short-term increases in mortality. Hot temperatures have also been associated with increased morbidity. The projected warming is therefore projected to increase heat related mortality and

morbidity, especially among the elderly, young and frail. The populations most sensitive to hot temperatures are older adults, the chronically sick, the very young, city-dwellers, those taking medications that disrupt thermoregulation, the mentally ill, those lacking access to air conditioning, those working or playing outdoors, and socially isolated persons. As warming increases over time, these adverse effects would be expected to increase as the serious heat events become more serious.

Increases in temperature are also expected to lead to some reduction in the risk of death related to extreme cold. Cold waves continue to pose health risks in northern latitudes in temperature regions where very low temperatures can be reached in a few hours and extend over long periods. Globally, the IPCC projects reduced human mortality from cold exposure through 2100. It is not clear whether reduced mortality in the United States from cold would be greater or less than increased heat-related mortality in the United States due to climate change. However, there is a risk that projections of cold-related deaths, and the potential for decreasing their numbers due to warmer winters, can be overestimated unless they take into account the effects of season and influenza, which is not strongly associated with monthly winter temperature. In addition, the latest USGCRP report refers to a study that analyzed daily mortality and weather data in 50 U.S. cities from 1989 to 2000 and found that, on average, cold snaps in the United States increased death rates by 1.6 percent, while heat waves triggered a 5.7 percent increase in death rates. The study concludes that increases in heat-related mortality due to global warming in the United States are unlikely to be compensated for by decreases in cold-related mortality.

b. Air Quality Effects

Increases in regional ozone pollution relative to ozone levels without climate change are expected due to higher temperatures and weaker circulation in the United States relative to air quality levels without climate change. Climate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death. In addition to human health effects, tropospheric ozone has significant adverse effects on crop yields, pasture and forest growth, and species composition. The directional effect of climate change on ambient particulate matter levels remains less certain.

Climate change can affect ozone by modifying emissions of precursors, atmospheric chemistry, and transport and removal. There is now consistent evidence from models and observations that 21st century climate change will worsen summertime surface ozone in polluted regions of North America compared to a future with no climate change.

Modeling studies discussed in EPA's Interim Assessment²⁸ show that simulated climate change causes increases in summertime ozone concentrations over substantial regions of the country, though this was not uniform, and some areas showed little change or decreases, though the decreases tend to be less pronounced than the increases. For those regions that showed climate-induced increases, the increase in maximum daily 8-hour average ozone concentration, a key metric for regulating U.S. air quality, was in the range of 2 to 8 ppb, averaged over the summer season. The increases were substantially greater than this during the peak pollution episodes that tend to occur over a number of days each summer. The overall effect of climate change was projected to increase ozone levels, compared to what would occur without this climate change, over broad areas of the country, especially on the highest ozone days and in the largest metropolitan areas with the worst ozone problems. Ozone decreases are projected to be less pronounced, and generally to be limited to some regions of the country with smaller population.

c. Effects on Extreme Weather Events

In addition to the direct effects of temperature on heat- and cold-related mortality, the Administrator considers the potential for increased deaths, injuries, infectious diseases, and stress-related disorders and other adverse effects associated with social disruption and migration from more frequent extreme weather. The Administrator notes that the vulnerability to weather disasters depends on the attributes of the people at risk (including where they live, age, income, education, and disability) and on broader social and environmental factors (level of disaster preparedness, health sector responses, and environmental degradation). The IPCC finds the following with regard to extreme events and human health:

²⁸ U.S. EPA (2009) *Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone*. An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC. EPA/600/R-07/094.

Increases in the frequency of heavy precipitation events are associated with increased risk of deaths and injuries as well as infectious, respiratory, and skin diseases. Floods are low-probability, high-impact events that can overwhelm physical infrastructure, human resilience, and social organization. Flood health impacts include deaths, injuries, infectious diseases, intoxications, and mental health problems.

Increases in tropical cyclone intensity are linked to increases in the risk of deaths, injuries, waterborne and food borne diseases, as well as post-traumatic stress disorders. Drowning by storm surge, heightened by rising sea levels and more intense storms (as projected by IPCC), is the major killer in coastal storms where there are large numbers of deaths. Flooding can cause health impacts including direct injuries as well as increased incidence of waterborne diseases due to pathogens such as *Cryptosporidium* and *Giardia*.

d. Effects on Climate-Sensitive Diseases and Aeroallergens

According to the assessment literature, there will likely be an increase in the spread of several food and water-borne pathogens among susceptible populations depending on the pathogens' survival, persistence, habitat range and transmission under changing climate and environmental conditions. Food borne diseases show some relationship with temperature, and the range of some zoonotic disease carriers such as the Lyme disease carrying tick may increase with temperature.

Climate change, including changes in carbon dioxide concentrations, could impact the production, distribution, dispersion and allergenicity of aeroallergens and the growth and distribution of weeds, grasses, and trees that produce them. These changes in aeroallergens and subsequent human exposures could affect the prevalence and severity of allergy symptoms. However, the scientific literature does not provide definitive data or conclusions on how climate change might impact aeroallergens and subsequently the prevalence of allergic illnesses in the United States.

It has generally been observed that the presence of elevated carbon dioxide concentrations and temperatures stimulate plants to increase photosynthesis, biomass, water use efficiency, and reproductive effort. The IPCC concluded that pollens are likely to increase with elevated temperature and carbon dioxide.

e. Summary of the Administrator's Finding of Endangerment to Public Health

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public health by evaluating the risks associated with changes in air quality, increases in temperatures, changes in extreme weather events, increases in food and water borne pathogens, and changes in aeroallergens. The evidence concerning adverse air quality impacts provides strong and clear support for an endangerment finding. Increases in ambient ozone are expected to occur over broad areas of the country, and they are expected to increase serious adverse health effects in large population areas that are and may continue to be in nonattainment. The evaluation of the potential risks associated with increases in ozone in attainment areas also supports such a finding.

The impact on mortality and morbidity associated with increases in average temperatures which increase the likelihood of heat waves also provides support for a public health endangerment finding. There are uncertainties over the net health impacts of a temperature increase due to decreases in cold-related mortality, but there is some recent evidence that suggests that the net impact on mortality is more likely to be adverse, in a context where heat is already the leading cause of weather-related deaths in the United States.

The evidence concerning how human-induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods. Additionally, public health is expected to be adversely affected by an increase in the severity of coastal storm events due to rising sea levels.

There is some evidence that elevated carbon dioxide concentrations and climate changes can lead to changes in aeroallergens that could increase the potential for allergenic illnesses. The evidence on pathogen borne disease vectors provides directional support for an endangerment finding. The Administrator acknowledges the many uncertainties in these areas. Although these adverse effects, provide some support for an endangerment finding, the Administrator is not placing primary weight on these factors.

Finally, the Administrator places weight on the fact that certain groups, including children, the elderly, and the poor, are most vulnerable to these climate-related health effects.

f. Key Comments on the Finding of Endangerment to Public Health

EPA received many comments on public health issues and the proposed finding of endangerment to public health.

i. EPA's Consideration of the Climate Impacts as Public Health Issues is Reasonable

Several commenters argue that EPA may only consider the health effects from direct exposure to pollutants in determining whether a pollutant endangers public health. The commenters state that EPA's proposal acknowledges that there is no evidence that greenhouse gases directly cause health effects, citing 74 FR 18901. To support their claim that EPA can only consider health effects that result from direct exposure to a pollutant, commenters cite several sources, discussed below.

Clean Air Act and Legislative History. Several commenters argue that the text of the CAA and the legislative history of the 1977 amendments demonstrate that Congress intended public health effects to relate to risks from direct exposure to a pollutant. They also argue that by considering health effects that result from welfare effects, EPA was essentially combining the two categories into one, contrary to the statute and Congressional intent.

Commenters state that the CAA, including CAA section 202(a)(1), requires EPA to consider endangerment of public health separately from endangerment of public welfare. Commenters note that while the CAA does not provide a definition of public health, CAA section 302(h) addresses the meaning of "welfare," which includes weather and climate. Thus, they argue, Congress has instructed that effects on weather and climate are to be considered as potentially endangering welfare—not human health. They continue that Congress surely knew that weather and climatic events such as flooding and heat waves could affect human health, but Congress nonetheless classified air pollutants' effects on weather and climate as effects on welfare.

Commenters also argue that the legislative history confirms that Congress intended for the definition of "public health" to only include the consequences of direct human exposure to ambient air pollutants. They note an

early version of section 109(b) would have required only a single NAAQS standard to protect "public health," with the protection of "welfare" being a co-benefit of the single standard.

Commenters note that the proponents of this early bill explained, "[i]n many cases, a level of protection of health would take care of the welfare situation" Sen. Hearing, Subcommittee on Air and Water Pollution, Comm. On Public Works (Mar. 17, 1970) (statement of Dr. Middleton, Comm'r. Nat'l Air Pollution Control Admin., HEW), 1970 Leg. Hist. 1194. Commenters state that the Senate bill that ultimately passed rejected this combined standard, requiring separate national ambient air quality standards and national ambient air quality goals. Commenters contend that Congress intended that the national ambient air quality goals be set "to protect the public health and welfare from any known or anticipated effects associated with" air pollution, including the list of "welfare" effects currently found in CAA section 302(h), such as effects on water, vegetation, animals, wildlife, weather and climate. Commenters note the Senate Committee Report stated that the national ambient air quality standards were created to protect public health, while the national ambient air quality goals were intended to address broader issues because "the Committee also recognizes that man's natural and man-made environment must be preserved and protected. Therefore, the bill provides for the setting of national ambient air quality goals at levels necessary to protect public health and welfare from any known or anticipated adverse effects of air pollution—including effects on soils, water, vegetation, man-made materials, animals, wildlife, visibility, climate, and economic values." Commenters argue this statement is clearly the source of the current definition of welfare effects in CAA section 302(h), which also includes "personal comfort and well being." They argue the Senate bill contemplated the NAAQS would include only direct health effects, while the goals would encompass effects on both the public health and welfare. Commenters continue that considering both public health effects and welfare effects under a combined standard, as the Administrator attempts to do in the proposed endangerment finding, would resurrect the combined approach to NAAQS that the Senate emphatically rejected.

The commenters also cite language from the House Report in support of their view that Congress only intended that EPA consider direct health effects

when assessing endangerment to public health: "By the words 'cause or contribute to air pollution,' the committee intends to require the Administrator to consider all sources of the contaminant which contributes to air pollution and to consider all sources of exposure to the contaminant—food, water, air, etc.—in determining health risks" 7 H.R. Rep. No. 95–294, at 49–50 (1977). Commenters also cite language in the Senate Report: "Knowledge of the relationship between the exposure to many air pollution agents and acute and chronic health effects is sufficient to develop air quality criteria related to such effects" S. Rep. No. 91–1196, at 7 (1970).

The specific issue here is whether an effect on human health that results from a change in climate should be considered when EPA determines whether the air pollution of well-mixed greenhouse gases is reasonably anticipated to endanger public health. In this case, the air pollution has an effect on climate. For example the air pollution raises surface, air, and water temperatures. Among the many effects that flow from this is the expectation that there will be an increase in the risk of mortality and morbidity associated with increased intensity of heat waves. In addition, there is an expectation that there will be an increase in levels of ambient ozone, leading to increased risk of morbidity and mortality from exposure to ozone. All of these are effects on human health, and all of them are associated with the effect on climate from elevated atmospheric concentrations of greenhouse gases. None of these human health effects are associated with direct exposure to greenhouse gases.

In the past, EPA has not had to resolve the issue presented here, as it has been clear whether the effects relate to public health or relate to public welfare, with no confusion over what category was at issue. In those cases EPA has routinely looked at what effect the air pollution has on people. If the effect on people is to their health, we have considered it an issue of public health. If the effect on people is to their interest in matters other than health, we have considered it public welfare.

For example, there are serious health risks associated with inhalation of ozone, and they have logically been considered as public health issues. Ambient levels of ozone have also raised the question of indirect health benefits through screening of harmful UVB rays. EPA has also considered this indirect health effect of ozone to be a

public health issue.²⁹ Ozone pollution also affects people by impacting their interests in various vegetation through foliar damage to trees, reduced crop yield, adverse impacts on horticultural plants, and the like. EPA has consistently considered these issues when evaluating the public welfare based NAAQS standards under CAA section 109.

In all of these situations the use of the term "public" has focused EPA on how people are affected by the air pollution. If the effect on people is to their health then we have considered it a public health issue. If the effect on people is to their interest in matters other than health, then we have treated it as a public welfare issue.

The situation presented here is somewhat unique. The focus again is on the effect the air pollution has on people. Here the effect on people is to their health. However this effect flows from the change in climate and effects on climate are included in the definition of effects on welfare. That raises the issue of how to categorize the health effects—should we consider them when evaluating endangerment to public health? When we evaluate endangerment to public welfare? Or both?

The text of the CAA does not resolve this question. While Congress defined "effects on welfare," it did not define either "public health" or "public welfare". In addition, the definition of "effects on welfare" does not clearly address how to categorize health effects that flow from effects on soils, water, crops, vegetation, weather, climate, or any of the other factors listed in CAA section 302(h). It is clear that effects on climate are an effect on welfare, but the definition does not address whether health impacts that are caused by these changes in climate are also effects on welfare. The health effects at issue are not themselves effects on soils, water, crops, vegetation, weather, or climate. They are instead effects on health. They

derive from the effects on climate, but they are not themselves effects on climate or on anything else listed in CAA section 302(h). So the definition of effects on welfare does not address whether an effect on health, which is not itself listed in CAA section 302(h), is also an effect on welfare if it results from an effect on welfare. The text of the CAA also does not address the issue of direct and indirect health effects. Contrary to commenters' assertions, the legislative history does not address or resolve this issue.

In this context, EPA is interpreting the endangerment provision in CAA section 202(a) as meaning that the effects on peoples' health from changes to climate can and should be included in EPA's evaluation of whether the air pollution at issue endangers public health. EPA is not deciding whether these health effects also could or should be considered in evaluating endangerment to public welfare.

The stating of the issue makes the answer seem straightforward. If air pollution causes sickness or death, then these health effects should be considered when evaluating whether the air pollution endangers public health. The term public health is undefined, and by itself this is an eminently reasonable way to interpret it. This focuses on the actual effect on people, as compared to ignoring that and focusing on the pathway from the air pollution to the effect. The question then becomes whether there is a valid basis in the CAA to take the different approach suggested by commenters, an approach contrary to the common sense meaning of public health.

Notably, the term "public welfare" is undefined. While it clearly means something other than public health, there is no obvious indication whether Congress intended there to be a clear boundary between the two terms or whether there might be some overlap where some impacts could be considered both a public health and a public welfare impact. Neither the text nor the legislative history resolves this issue. Under either approach, EPA believes the proper interpretation is that these effects on health should be considered when evaluating endangerment to public health.

If we assume Congress intended that effects on public welfare could not include effects on public health and vice versa, then the effects at issue here should most reasonably be considered in the public health category. Indisputably they are health effects, and the plain meaning of the term public health would call for their inclusion in that term. The term public welfare is

²⁹ As discussed later, in the past EPA took the position that this kind of potential indirect beneficial impact on public health should not be considered when setting the primary health based NAAQS for ozone. This was not based on the view that it was not a potential public health impact, or that it was a public welfare impact instead of a public health impact. Instead EPA was interpreting the NAAQS standard setting provisions of section 109, and argued that they were intended to address only certain public health impacts, those that were adverse, and were not intended to address indirect, beneficial public health impacts. This interpretation of section 109 was rejected in *ATA v. EPA*, 175 F.3d 1027 (1999) *reh'g granted in part and denied in part*, 195 F.3d 4 (DC Cir. 1999). The court made it clear that the potential indirect beneficial impact of ambient ozone on public health from screening UVB rays needed to be considered when setting the NAAQS to protect public health.

undefined. If Congress intended that public welfare not include matters included in the public health category, then a reasonable interpretation of this undefined term would include those effects on welfare that impact people in ways other than impacting their health.

The definition of "effects on welfare" does not clearly address how to categorize health effects that flow from effects on water, soil, land, climate, or weather. As noted above, the definition does not address whether health impacts that are caused by these changes in climate are also "effects on welfare." Certainly effects on health are not included in the list in CAA section 302(h). The lack of clarity in the definition of effects on welfare, combined with the lack of definition of public welfare, do not warrant interpreting the term public health differently from its straightforward and common sense meaning.

The inclusion of the phrase "effects on * * * personal comfort and well-being" as an effect on welfare supports this view. The term would logically mean something other than the different term public health. The term "well-being" is not defined, and generally has a broader and different connotation of positive physical, emotional, and mental status. The most straightforward meaning of this term, in a context where Congress used the different term public health in a wide variety of other provisions, would be to include effects on people that do not rise to the level of health effects, but otherwise impact their physical, emotional, and mental status. This gives full meaning to both terms.

The term well-being is a general term, and in isolation arguably could include health effects. However there is no textual basis to say it would include some health effects but not others, as argued by commenters. If sickness impacts your well-being, then it impacts your well-being whether it results directly or indirectly from the pollution in the air. Nothing in CAA section 302(h) limits the term well-being to indirect impacts on people, or to health effects that occur because of other welfare effects, such as climate change. It is listed as its own effect on welfare. Instead of interpreting well-being as including all health effects, or some health effects, the much more logical way to interpret this provision in the context of all of the other provisions of the CAA is to interpret it as meaning effects on people other than health effects.

Thus, if Congress intended to draw a strict line between the two categories of public health and public welfare, for

purposes of determining endangerment under CAA section 202(a), then EPA believes that its interpretation is a reasonable and straightforward way to categorize the health effects at issue here. This gives weight to the common sense meaning of the term public health, where the terms public health and public welfare are undefined and the definition of effects on welfare is at best ambiguous on this issue.

In the alternative, if Congress did not intend any such bright line between these two categories and there could be an overlap, then it is also reasonable for EPA to include these health effects in its consideration of whether the air pollution endangers public health. Neither approach condenses or conflates the two different terms. Under either approach EPA's interpretation, as demonstrated in this rulemaking, would still consider numerous and varied effects from climate change as indisputable impacts on public welfare and not impacts on public health. In addition, this interpretation will not change the fact that in almost all cases impacts on public health would not also be considered impacts on public welfare.

Prior EPA actions. Several commenters argue that EPA's decision to include health impacts that occur because of climate change is inconsistent with its past approach, which has been to treat indirect health effects as welfare effects. Commenters contend that in the latest Criteria Document for ozone EPA listed tropospheric ozone's effects on UVB-induced human diseases, as well as its effects on climate change, as welfare effects, even though the agency acknowledged significant health effects such as sunburn and skin cancer. Commenters also argue that EPA listed "risks to human health" from toxins released by algal blooms due to excess nitrogen as "ecological and other welfare effects" in the recent Criteria Document for oxides of nitrogen and sulfur. Finally, commenters argue that EPA's proposed action was contrary to the Agency decision to list new municipal solid waste landfills as a source category under CAA section 111. Commenters state that EPA listed climate change as a welfare effect in that action, (citing 56 FR 24469).

The Agency's recent approach regarding UVB-induced health effects is consistent with the endangerment findings, and demonstrates that the Agency considers indirect effects on human health as public health issues rather than public welfare issues. While the ozone Criteria Document may have placed the discussion of UV-B related

health effects among chapters on welfare effects, in evaluating the evidence presented in the Criteria Document for purposes of preparing the policy assessment document, EPA staff clearly viewed UVB-induced effects as human health effects that were relevant in determining the public health based primary NAAQS for ozone, rather than welfare effects, regardless of which chapter in the Criteria Document described those effects. The evaluation of the UVB-related evidence is discussed with other human health effects evidence. The policy assessment document noted that Chapter 10 of the Criteria Document, "provides a thorough analysis of the current understanding of the relationship between reducing tropospheric [ozone] concentrations and the potential impact these reductions might have on UV-B surface fluxes and indirectly contributing to increased UV-B related health effects." See, *Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information*, p 3-36 (January 2007) (emphasis added).

EPA repeated this view in the 2007 proposed ozone NAAQS rule. In presenting its evaluation of the human health evidence for purposes of setting the public health based primary NAAQS, EPA stated: "This section also summarizes the uncertainty about the potential indirect effects on public health associated with changes due to increases in UV-B radiation exposure, such as UV-B radiation-related skin cancers, that may be associated with reductions in ambient levels of ground-level [ozone], as discussed in chapter 10 of the Criteria Document and chapter 3 of the Staff Paper." 72 FR 37618, 37627. See also, 72 FR 37837 ("* * * the Criteria Document also assesses the potential indirect effects related to the presence of [ozone] in the ambient air by considering the role of ground-level [ozone] in mediating human health effects that may be directly attributable to exposure to solar ultraviolet radiation (UV-B).")

Thus, EPA's approach to UV-B related health effects clearly shows the Agency has treated indirect health effects not as welfare effects, as commenters suggest, but as human health effects that need to be evaluated when setting the public health based primary NAAQS. In this ozone NAAQS rulemaking, EPA did not draw a line between direct and indirect health effects for purposes of evaluating UV-B related health effects and the public health based primary NAAQS.

Similarly, the NO_x/SO_x criteria document does not establish a precedent that indirect human health effects are welfare effects. Toxic algal blooms themselves are a welfare effect, so it is not surprising a discussion of algal blooms appears in sections dealing with welfare effects. The more relevant question is how EPA evaluated information regarding human health risks resulting from algal blooms. In the case of the Criteria Document, the role of nitrogen in causing algal blooms was unclear. As a result, the Agency did not have occasion to evaluate any resulting human health effects and the Criteria Document does not support the view that EPA treats indirect health effects as anything other than a public health issue.

Finally, EPA disagrees that its action here is at odds with the listing of municipal solid waste landfills under CAA section 111. In the landfills New Source Performance Standard (NSPS) EPA did not consider health effects resulting from climate change much less draw any conclusions about health effects from climate change being health or welfare effects. If anything, the landfills NSPS is consistent with EPA's approach. In the proposed rule, EPA stated: "The EPA has documented many cases of acute injury and death caused by explosions and fires related to municipal landfill gas emissions. In addition to these health effects, the associated property damage is a welfare effect" (56 FR 24474). EPA considered injury and death from fires resulting from landfill gasses to be health effects. Yet the injury did not result from direct exposure to the pollutant (landfill gas). Instead, the injury resulted from the combustion of the pollutant—the injury is essentially an indirect effect of the pollutant. Yet, as with this action, EPA considered the injury as a human health effect.

Case law. Several commenters argue that EPA's proposed endangerment finding was inconsistent with *NRDC v. EPA*, 902 F.2d 962 (DC Cir 1990). Commenters argue that in rejecting the argument that EPA must consider the health effects of increased unemployment that could result from a more stringent primary NAAQS standard, the DC Circuit explained that, "[i]t is only the health effects relating to pollutants in the air that EPA may consider." *Id.* at 973. Several commenters further argue that EPA later relied on that holding to defend its decision to set a primary NAAQS for ozone based solely on direct health effects of ozone. Citing, *EPA Pet'n for Rehearing, Am. Trucking Ass'n v. EPA*, No. 97-1440 (DC Cir. June 28, 1999)

("ATA I") (arguing that the primary NAAQS should be set through consideration of only "direct adverse effects on public health, and not indirect, allegedly beneficial effects.")

The *NRDC* case is not contrary to EPA's endangerment finding. In *NRDC*, petitioner American Iron and Steel Institute argued that EPA had to consider the costs of health consequences that might arise from increased unemployment. The court ruled that, "[c]onsideration of costs associated with alleged health risks from unemployment would be flatly inconsistent with the statute, legislative history and case law on this point." 902 F.2d at 973. The cases cited by the court in support of its decision all hold that EPA may not consider economic or technological feasibility in establishing a NAAQS. The *NRDC* decision does not establish a precedent that the CAA prohibits EPA from considering indirect health effects as a public health issue, rather than a public welfare issue.

EPA also believes reliance on the Agency's petition for rehearing in noted above is misplaced. In that case, EPA did not argue that indirect beneficial health effects were not public health issues. Instead EPA argued that under the CAA, it did not have to consider such indirect beneficial health effects of an air pollutant when setting the health based primary NAAQS. EPA was interpreting the NAAQS standard setting provisions of CAA section 109, and argued that they were intended to address only certain public health impacts, those that were adverse, and were not intended to address indirect, beneficial public health impacts. The issue in the case was not whether indirect health effects are relevant for purposes of making an endangerment decision concerning public health, but rather whether EPA must consider such beneficial health effects in establishing a primary NAAQS under CAA section 109. EPA's interpretation of CAA section 109 was rejected in *ATA v. EPA*, 175 F.3d at 1027 (1999) *reh'g granted in part and denied in part*, 195 F.3d at 4 (DC Cir. 1999). The court made it clear that the potential indirect beneficial impact of ambient ozone on public health from screening UVB rays needed to be considered when setting the NAAQS to protect public health. As discussed above, EPA has done just that as noted above in the UV-B context. Moreover, as discussed in Section II of these Findings, EPA is doing that here as well (*e.g.*, considering any benefits from reduced cold weather related deaths).

ii. EPA's Treatment and Balancing of Heat- vs. Cold-Related Public Health Risks Was Reasonable

A number of public commenters maintain that the risk of heat waves in the future will be modulated by adaptive measures. The Administrator is aware of the potential benefits of adaptation in reducing heat-related morbidity and mortality and recognizes most heat-related deaths are preventable. Nonetheless, the Administrator notes the assessment literature³⁰ indicates heat is the leading weather-related killer in the United States even though countermeasures have been employed in many vulnerable areas. Given projections for heat waves of greater frequency, magnitude, and duration coupled with a growing population of older adults (among the most vulnerable groups to this hazard), the risk of adverse health outcomes from heat waves is expected to increase. Intervention and response measures could certainly reduce the risk, but as we have noted, the need to adapt supports an increase in risk or endangerment. For a general discussion about EPA's treatment of adaptation see Section III.C of these Findings.

Several commenters also suggest cold-related mortality will decrease more than heat-related mortality will increase, which indicates a net reduction in temperature-related mortality. Some commenters point to research suggesting migration to warmer climates has contributed to the increased longevity of some Americans, implying climate warming will have benefits for health. The Administrator is very clear that the exact balance of how heat- versus cold-related mortality will change in the future is uncertain; however, the assessment literature points to evidence suggesting that the increased risk from heat would exceed the decreased risk from cold in a warming climate. The Administrator does not dispute research indicating the benefits of migration to a warmer climate and nor that average climate warming may indeed provide health benefits in some areas. These points are reflected in the TSD's statement projecting less cold-related health effects. The Administrator considers these potential warming benefits independent of the potential negative effects of extreme heat events which are projected to increase under future climate change scenarios affecting vulnerable groups and communities.

³⁰ Karl *et al.* (2009).

iii. EPA Was Reasonable To Find That the Air Quality Impacts of Climate Change Contribute to the Endangerment of Public Health

Several commenters suggest that air quality effects of climate change will be addressed through the CAA's NAAQS process, as implemented by the State Implementation Plans (SIP) and national regulatory programs. According to these commenters, these programs will ensure no adverse impact on public health due to climate change. Though climate change may cause certain air pollutant ambient concentrations to increase, States will continue to be compelled to meet the standards. So, while additional measures may be necessary, and result in increased costs, these commenters assert that, ultimately, public health will be protected by the continued existence of the NAAQS and therefore no endangerment with respect to this particular climate change-related impact will occur. One commenter states that EPA inappropriately assigns air quality risk to climate change that will be addressed through other programs. The CAA provides a mechanism to meet the standards and additional control measures consistent with the CAA will be adopted in the future, keeping pollution below unhealthy levels. The commenters state that the fact that NAAQS are in place that require EPA to fulfill its legal obligation to prevent this particular form of endangerment to public health.

EPA does have in place NAAQS for ozone, which are premised on the harmfulness of ozone to public health and welfare. These standards and their accompanying regulatory regime have helped to reduce the dangers from ozone in the United States. However, substantial challenges remain with respect to achieving the air quality protection promised by the NAAQS for ozone. It is the Administrator's view that these challenges will be exacerbated by climate change.

In addition, the control measures to achieve attainment with a NAAQS are a mitigation measure aimed at reducing emissions of ozone precursors. As discussed in Section III.C of these Findings, EPA is not considering the impacts of mitigation with respect to future reductions in emissions of greenhouse gases. For the same reasons, EPA is reasonably not considering mitigation in the form of the control measures that will need to be adopted in the future to reduce emissions of ozone precursors and thereby address the increased ambient ozone levels that can occur because of climate change.

It is important to note that controls to meet the NAAQS are typically put in place only *after* air quality concentrations exceeding the standard are detected. Furthermore, implementation of controls to reduce ambient concentrations of pollutants occurs over an extended time period, ranging from three years to more than twenty years depending on the pollutant and the seriousness of the nonattainment problem. Thus, while the CAA provides mechanisms for addressing adverse health effects and the underlying air quality exacerbation over time, it will not prevent the adverse impacts in the interim. Given the serious nature of the health effects at issue—including respiratory and cardiovascular disease leading to hospital admissions, emergency department visits, and premature mortality—this increase in adverse impacts during the time before additional controls can be implemented is a serious public health concern. Historically, a large segment of the U.S. population has lived in areas exceeding the NAAQS, despite the CAA and its implementation efforts. Half of all Americans, 158 million people, live in counties where air pollution exceeds national health standards.³¹ Where attainment of the NAAQS is especially difficult, leading to delays in meeting attainment deadlines, the health effects of increased ozone due to climate change may be substantial.

It is also important to note that it may not be possible for States and Tribes to plan accurately for the impacts of climate change in developing control strategies for nonattainment areas. As noted in the TSD and EPA's 2009 Interim Assessment report (IA), climate change is projected to lead to an increase in the variability of weather, and this may increase peak pollution events including increases in ozone exceedances. While the modeling studies in the IA all show significant future changes in meteorological quantities, there is also significant variability across the simulations in the spatial patterns of these future changes, making it difficult to select a set of future meteorological data for planning purposes. At this time, models used to develop plans to attain the NAAQS do not take potential changes in future meteorology into consideration. Inability to predict the frequency and magnitude of such events could lead to an underestimation of the controls needed to bring areas into attainment,

and a prolonged period during which adverse health impacts continue to occur.

Even in areas that meet the NAAQS currently, air quality may deteriorate sufficiently to cause adverse health effects for some individuals. Some at-risk individuals, for example those with preexisting health conditions or other characteristics which increase their risk for adverse effects upon exposure to PM or ozone, may experience health effects at levels below the standard. Current evidence suggests that there is no threshold for PM or ozone concentrations below which no effects can be observed. Therefore, increases in ozone or PM in locations that currently meet the standards would likely result in additional adverse health effects for some individuals, even though the pollution increase might not be sufficient to cause the area to be designated nonattainment. While the NAAQS is set to protect public health with an adequate margin of safety, it is recognized that in attainment areas there may be individuals who remain at greater risk from an increase in ozone levels. The clear risk to the public from ozone increases in nonattainment areas, in combination with the risk to some individuals in attainment areas, supports the finding that overall the public health is endangered by increases in ozone resulting from climate change.

Finally, it is also important to note that not all air pollution events are subject to CAA controls under the NAAQS implementation provisions. "Exceptional events" are events for which the normal planning and regulatory process established by the CAA is not appropriate (72 FR 13561). Emissions from some events, including some wildfires, are not reasonably controllable or preventable. Such emissions, however, can adversely impact public health and welfare and are expected to increase due to climate change. As described in the TSD, PM emissions from wildfires can contribute to acute and chronic illnesses of the respiratory system, particularly in children, including pneumonia, upper respiratory diseases, asthma and chronic obstructive pulmonary disease. The IPCC (Field et al., 2007) reported with very high confidence that in North America, disturbances like wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons.

2. The Air Pollution Is Reasonably Anticipated to Endanger Public Welfare

The Administrator also finds that the well-mixed greenhouse gas air pollution may reasonably be anticipated to

³¹ U.S. EPA (2008) National Air Quality: Status and Trends Through 2007. EPA-454/R-08-005, November 2008.

endanger public welfare, both for current and future generations.

As with public health, the Administrator considered the multiple pathways in which the greenhouse gas air pollution and resultant climate change affect climate-sensitive sectors, and the impact this may have on public welfare. These sectors include food production and agriculture; forestry; water resources; sea level rise and coastal areas; energy, infrastructure, and settlements; and ecosystems and wildlife. The Administrator also considered impacts on the U.S. population from climate change effects occurring outside of the United States, such as national security concerns for the United States that may arise as a result of climate change impacts in other regions of the world. The Administrator examined each climate-sensitive sector individually, informed by the summary of the scientific assessments contained in the TSD, and the full record before EPA, and weighed the extent to which the risks and impacts within each sector support or do not support a positive endangerment finding in her judgment. The Administrator then viewed the full weight of evidence looking across all sectors to reach her decision regarding endangerment to public welfare.

a. Food Production and Agriculture

Food production and agriculture within the United States is a sector that will be affected by the combined effects of elevated carbon dioxide concentrations and associated climate change. The Administrator considered how these effects, both adverse and beneficial, are affecting the agricultural sector now and in the future, and over different regions of the United States, taking into account that different regions of the country specialize in different agricultural products with varying degrees of sensitivity and vulnerability to elevated carbon dioxide levels and associated climate change.

Elevated carbon dioxide concentrations can have a stimulatory effect on grain and oilseed crop yield, as may modest temperature increases and a longer growing season that results. A report under the USGCRP concluded that, with increased carbon dioxide and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. However, such beneficial influences need to be considered in light of various other effects. For example, the literature indicates that elevated carbon dioxide concentrations may also enhance pest and weed growth. Pests and weeds can reduce crop yields, cause economic losses to

farmers, and require management control options. How climate change (elevated carbon dioxide, increased temperatures, altered precipitation patterns, and changes in the frequency and intensity of extreme events) may affect the prevalence of pests and weeds is an issue of concern for food production and the agricultural sector. Research on the combined effects of elevated carbon dioxide and climate change on pests, weeds, and disease is still limited. In addition, higher temperature increases, changing precipitation patterns and variability, and any increases in ground-level ozone induced by higher temperatures, can work to counteract any direct stimulatory carbon dioxide effect, as well as lead to their own adverse impacts. There may be large regional variability in the response of food production and agriculture to climate change.

For grain and oilseed crop yields, there is support for the view that in the near term climate change may have a beneficial effect, largely through increased temperature and increased carbon dioxide levels. However there are also factors noted above, some of which are less well studied and understood, which would tend to offset any near term benefit, leaving significant uncertainty about the actual magnitude of any overall benefit. The USGCRP report also concluded that as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable.

A key uncertainty is how human-induced climate change may affect the intensity and frequency of extreme weather events such as droughts and heavy storms. These events have the potential to have serious negative impact on U.S. food production and agriculture, but are not always taken into account in studies that examine how average conditions may change as a result of carbon dioxide and temperature increases. Changing precipitation patterns, in addition to increasing temperatures and longer growing seasons, can change the demand for irrigation requirements, potentially increasing irrigation demand.

Another key uncertainty concerns the many horticultural crops (e.g., tomatoes, onions, fruits), which make up roughly 40 percent of total crop value in the United States. There is relatively little information on their response to carbon dioxide, and few crop simulation models, but according to the literature, they are very likely to be more sensitive

to the various effects of climate change than grain and oilseed crops.

With respect to livestock, higher temperatures will very likely reduce livestock production during the summer season in some areas, but these losses will very likely be partially offset by warmer temperatures during the winter season. The impact on livestock productivity due to increased variability in weather patterns will likely be far greater than effects associated with the average change in climatic conditions. Cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges.

Finally, with respect to irrigation requirements, the adverse impacts of climate change on irrigation water requirements may be significant.

There is support for the view that there may be a benefit in the near term in the crop yield for certain crops. This potential benefit is subject to significant uncertainty, however, given the offsetting impact on the yield of these crops from a variety of other climate change impacts that are less well understood and more variable. Any potential net benefit is expected to change to a disbenefit in the longer term. In addition, there is clear risk that the sensitivity of a major segment of the total crop market, the horticultural sector, may lead to adverse effects from climate change. With respect to livestock production and irrigation requirements, climate change is likely to have adverse effects in both the near and long terms. The impact on fisheries varies, and would appear to be best viewed as neutral overall.

There is a potential for a net benefit in the near term for certain crops, but there is significant uncertainty about whether this benefit will be achieved given the various potential adverse impacts of climate change on crop yield, such as the increasing risk of extreme weather events. Other aspects of this sector are expected to be adversely affected by climate change, including livestock management and irrigation requirements, and there is a risk of adverse effect on a large segment of the total crop market. For the near term, the concern over the potential for adverse effects in certain parts of the agriculture sector appears generally comparable to the potential for benefits for certain crops.

However, considering the trend over near- and long-term future conditions, the Administrator finds that the body of evidence points towards increasing risk

of net adverse impacts on U.S. food production and agriculture, with the potential for significant disruptions and crop failure in the future.

b. Forestry

The factors that the Administrator considered for the U.S. forest sector are similar to those for food production and agriculture. There is the potential for beneficial effects due to elevated concentrations of carbon dioxide and increased temperature, as well as the potential for adverse effects from increasing temperatures, changing precipitation patterns, increased insects and disease, and the potential for more frequent and severe extreme weather events. The potential beneficial effects are better understood and studied, and are limited to certain areas of the country and types of forests. The adverse effects are less certain, more variable, and also include some of the most serious adverse effects such as increased wildfire, drought, and major losses from insects and disease. As with food production and agriculture, the judgment to be made is largely a qualitative one, balancing impacts that vary in certainty and magnitude, with the end result being a judgment as to the overall direction and general level of concern.

According to the underlying science assessment reports, climate change has very likely increased the size and number of wildfires, insect outbreaks, and tree mortality in the Interior West, the Southwest, and Alaska, and will continue to do so. Rising atmospheric carbon dioxide levels will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils. Nitrogen deposition and warmer temperatures have very likely increased forest growth where water is not limiting and will continue to do so in the near future.

An increased frequency of disturbance (such as drought, storms, insect-outbreaks, and wildfire) is at least as important to forest ecosystem function as incremental changes in temperature, precipitation, atmospheric carbon dioxide, nitrogen deposition, and ozone pollution. Disturbances partially or completely change forest ecosystem structure and species composition, cause short-term productivity and carbon storage loss, allow better opportunities for invasive alien species to become established, and command more public and management attention and resources. The combined effects of expected increased temperature, carbon dioxide, nitrogen deposition, ozone, and forest

disturbance on soil processes and soil carbon storage remain unclear.

Precipitation and weather extremes are key to many forestry impacts, accounting for part of the regional variability in forest response. If existing trends in precipitation continue, it is expected that forest productivity will likely decrease in the Interior West, the Southwest, eastern portions of the Southeast, and Alaska, and that forest productivity will likely increase in the northeastern United States, the Lake States, and in western portions of the Southeast. An increase in drought events will very likely reduce forest productivity wherever such events occur.

Changes in disturbance patterns are expected to have a substantial impact on overall gains or losses. More prevalent wildfire disturbances have recently been observed in the United States. Wildfires and droughts, among other extreme events (e.g., hurricanes) that can cause forest damage, pose the largest threats over time to forest ecosystems.

For the near term, the Administrator believes the beneficial impact on forest growth and productivity in certain parts of the country from climate change to be more than offset by the clear risk from the more significant and serious adverse effects from the observed increases in wildfires, combined with the adverse impacts on growth and productivity in other areas of the country and the serious risks from the spread of destructive pests and disease. Increased wildfires can also increase particulate matter and thus create public health concerns as well. For the longer term, the Administrator views the risk from adverse effects to increase over time, such that overall climate change presents serious adverse risks for forest productivity. The Administrator therefore finds there is compelling reason to find that the greenhouse gas air pollution endangers U.S. forestry in both the near and long term, with the support for a positive endangerment finding only increasing as one considers expected future conditions in which temperatures continue to rise.

c. Water Resources

The sensitivity of water resources to climate change is very important given the increasing demand for adequate water supplies and services for agricultural, municipal, and energy and industrial uses, and the current strains on this resource in many parts of the country.

According to the assessment literature, climate change has already altered, and will likely continue to alter, the water cycle, affecting where, when,

and how much water is available for all uses. With higher temperatures, the water-holding capacity of the atmosphere and evaporation into the atmosphere increase, and this favors increased climate variability, with more intense precipitation and more droughts.

Climate change is causing and will increasingly cause shrinking snowpack induced by increasing temperature. In the western United States, there is already well-documented evidence of shrinking snowpack due to warming. Earlier meltings, with increased runoff in the winter and early spring, increase flood concerns and also result in substantially decreased summer flows. This pattern of reduced snowpack and changes to the flow regime pose very serious risks to major population regions, such as California, that rely on snowmelt-dominated watersheds for their water supply. While increased precipitation is expected to increase water flow levels in some eastern areas, this may be tempered by increased variability in the precipitation and the accompanying increased risk of floods and other concerns such as water pollution.

Warmer temperatures and decreasing precipitation in other parts of the country, such as the Southwest, can sustain and amplify drought impacts. Although drought has been more frequent and intense in the western part of the United States, the East is also vulnerable to droughts and attendant reductions in water supply, changes in water quality and ecosystem function, and challenges in allocation. The stress on water supplies on islands is expected to increase.

The impact of climate change on groundwater as a water supply is regionally variable; efforts to offset declining surface water availability due to increasing precipitation variability may be hampered by the fact that groundwater recharge will decrease considerably in some already water-stressed regions. In coastal areas, the increased salinization from intrusion of salt water is projected to have negative effects on the supply of fresh water.

Climate change is expected to have adverse effects on water quality. The IPCC concluded with high confidence that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution and can impact ecosystems, human health, and water system reliability and operating costs. These changes will also exacerbate many forms of water pollution, potentially making attainment of water quality goals more

difficult. Water pollutants of concern that are particularly relevant to climate change effects include sediment, nutrients, organic matter, pathogens, pesticides, salt, and thermal pollution. As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to warmer water. In the long term, warmer water, changing flows, and decreased water quality may result in deterioration of aquatic ecosystems.

Climate change will likely further constrain already over-allocated water resources in some regions of the United States, increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations. Increased incidence of extreme weather and floods may also overwhelm or damage water treatment and management systems, resulting in water quality impairments. In the Great Lakes and major river systems, lower water levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and bi-national relationships.

The Administrator finds that the total scientific literature provides compelling support for finding that greenhouse gas air pollution endangers the water resources important for public welfare in the United States, both for current and future generations. The adequacy of water supplies across large areas of the country is at serious risk from climate change. Even areas of the country where an increase in water flow is projected could face water resource problems from the variability of the supply and water quality problems associated with precipitation variability, and could face the serious adverse effects from risks from floods and drought. Climate change is expected to adversely affect water quality. There is an increased risk of serious adverse effects from extreme events of flooding and drought. The severity of risks and impacts may only increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

d. Sea Level Rise and Coastal Areas

A large percentage of the U.S. population lives in coastal areas, which are particularly vulnerable to the risks posed by climate change. The most

vulnerable areas are the Atlantic and Gulf Coasts, the Pacific Islands, and parts of Alaska.

According to the assessment literature, sea level is rising along much of the U.S. coast, and the rate of change will very likely increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Cities such as New Orleans, Miami, and New York are particularly at risk, and could have difficulty coping with the sea level rise projected by the end of the century under a higher emissions scenario. Population growth and the rising value of infrastructure increases the vulnerability to climate variability and future climate change in coastal areas. Adverse impacts on islands present concerns for Hawaii and the U.S. territories. Reductions in Arctic sea ice increases extreme coastal erosion in Alaska, due to the increased exposure of the coastline to strong wave action. In the Great Lakes, where sea level rise is not a concern, both extremely high and low water levels resulting from changes to the hydrological cycle have been damaging and disruptive to shoreline communities.

Coastal wetland loss is being observed in the United States where these ecosystems are squeezed between natural and artificial landward boundaries and rising sea levels. Up to 21 percent of the remaining coastal wetlands in the U.S. mid-Atlantic region are potentially at risk of inundation between 2000 and 2100. Coastal habitats will likely be increasingly stressed by climate change impacts interacting with development and pollution.

Although increases in mean sea level over the 21st century and beyond will inundate unprotected, low-lying areas, the most devastating impacts are likely to be associated with storm surge. Superimposed on expected rates of sea level rise, projected storm intensity, wave height, and storm surge suggest more severe coastal flooding and erosion hazards. Higher sea level provides an elevated base for storm surges to build upon and diminishes the rate at which low-lying areas drain, thereby increasing the risk of flooding from rainstorms. In New York City and Long Island, flooding from a combination of sea level rise and storm surge could be several meters deep. Projections suggest that the return period of a 100-year flood event in this area might be reduced to 19–68 years, on average, by the 2050s, and to 4–60 years by the 2080s. Additionally, some major urban centers in the United States, such as areas of New Orleans are situated in low-lying flood plains,

presenting increased risk from storm surges.

The Administrator finds that the most serious risk of adverse effects is presented by the increased risk of storm surge and flooding in coastal areas from sea level rise. Current observations of sea level rise are now contributing to increased risk of storm surge and flooding in coastal areas, and there is reason to find that these areas are now endangered by human-induced climate change. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense with increasing temperatures (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. The Administrator has concluded that even if there is a low probability of raising the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution.

In addition, coastal areas face other adverse impacts from sea level rise such as shoreline retreat, erosion, wetland loss and other effects. The increased risk associated with these adverse impacts also endangers the welfare of current and future generations, with an increasing risk of greater adverse impacts in the future.

Overall, the evidence on risk of adverse impacts for coastal areas from sea level rise provides clear support for finding that greenhouse gas air pollution endangers the welfare of current and future generations.

e. Energy, Infrastructure and Settlements

The Administrator also considered the impacts of climate change on energy consumption and production, and on key climate-sensitive aspects of the nation's infrastructure and settlements.

For the energy sector, the Administrator finds clear evidence that temperature increases will change heating and cooling demand, and to varying degrees across the country; however, under current conditions it is unclear whether or not net demand will increase or decrease. While the impacts on net energy demand may be viewed as generally neutral for purposes of making an endangerment determination, climate change is expected to call for an increase in electricity production, especially supply for peak demand. The U.S. energy sector, which relies heavily on water for cooling capacity and

hydropower, may be adversely impacted by changes to water supply in reservoirs and other water bodies.

With respect to infrastructure, climate change vulnerabilities of industry, settlement and society are mainly related to extreme weather events rather than to gradual climate change. The significance of gradual climate change, *e.g.*, increases in the mean temperature, lies mainly in changes in the intensity and frequency of extreme events. Extreme weather events could threaten U.S. energy infrastructure (transmission and distribution), transportation infrastructure (roads, bridges, airports and seaports), water infrastructure, and other built aspects of human settlements. Moreover, soil subsidence caused by the melting of permafrost in the Arctic region is a risk to gas and oil pipelines, electrical transmission towers, roads, and water systems. Vulnerabilities for industry, infrastructures, settlements, and society to climate change are generally greater in certain high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Additionally, infrastructures are often connected, meaning that an impact on one can also affect others.

A significant fraction of U.S. infrastructure is located in coastal areas. In these locations, rising sea levels are likely to lead to direct losses (*e.g.*, equipment damage from flooding) as well as indirect effects such as the costs associated with raising vulnerable assets to higher levels. Water infrastructure, including drinking water and wastewater treatment plants, and sewer and storm water management systems, may be at greater risk of flooding, sea level rise and storm surge, low flows, saltwater intrusion, and other factors that could impair performance and damage costly investments.

Within settlements experiencing climate change stressors, certain parts of the population may be especially vulnerable based on their circumstances. These include the poor, the elderly, the very young, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. In Alaska, indigenous communities are likely to experience disruptive impacts, including shifts in the range or abundance of wild species crucial to their livelihoods and well-being.

Overall, the evidence strongly supports the view that climate change presents risks of serious adverse impacts on public welfare from the risk to energy production and distribution as

well as risks to infrastructure and settlements.

f. Ecosystems and Wildlife

The Administrator considered the impacts of climate change on ecosystems and wildlife and the services they provide. The Administrator finds clear evidence that climate change is exerting major influences on natural environments and biodiversity, and these influences are generally expected to grow with increased warming. Observed changes in the life cycles of plants and animals include shifts in habitat ranges, timing of migration patterns, and changes in reproductive timing and behavior.

The underlying assessment literature finds with high confidence that substantial changes in the structure and functioning of terrestrial ecosystems are very likely to occur with a global warming greater than 2 to 3 °C above pre-industrial levels, with predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services. With global average temperature changes above 2 °C, many terrestrial, freshwater, and marine species (particularly endemic species) are at a far greater risk of extinction than in the geological past. Climate change and ocean acidification will likely impair a wide range of planktonic and other marine calcifiers such as corals. Even without ocean acidification effects, increases in sea surface temperature of about 1–3 °C are projected to result in more frequent coral bleaching events and widespread mortality. In the Arctic, wildlife faces great challenges from the effects of climatic warming, as projected reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals, and other animals.

Some common forest types are projected to expand, such as oak-hickory, while others are projected to contract, such as maple-beech-birch. Still others, such as spruce-fir, are likely to disappear from the contiguous United States. Changes in plant species composition in response to climate change can increase ecosystem vulnerability to other disturbances, including wildfires and biological invasion. Disturbances such as wildfires and insect outbreaks are increasing in the United States and are likely to intensify in a warmer future with warmer winters, drier soils and longer growing seasons. The areal extent of drought-limited ecosystems is projected to increase 11 percent per °C warming in the United States. In California, temperature increases greater than 2 °C may lead to conversion of shrubland

into desert and grassland ecosystems and evergreen conifer forests into mixed deciduous forests. Greater intensity of extreme events may alter disturbance regimes in coastal ecosystems leading to changes in diversity and ecosystem functioning. Species inhabiting salt marshes, mangroves, and coral reefs are likely to be particularly vulnerable to these effects.

The Administrator finds that the total scientific record provides compelling support for finding that the greenhouse gas air pollution leads to predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services for ecosystems and wildlife important for public welfare in the U.S., both for current and future generations. The severity of risks and impacts may only increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

g. Summary of the Administrator's Finding of Endangerment to Public Welfare

The Administrator has considered how elevated concentrations of the well-mixed greenhouse gases and associated climate change affect public welfare by evaluating numerous and far-ranging risks to food production and agriculture, forestry, water resources, sea level rise and coastal areas, energy, infrastructure, and settlements, and ecosystems and wildlife. For each of these sectors, the evidence provides support for a finding of endangerment to public welfare. The evidence concerning adverse impacts in the areas of water resources and sea level rise and coastal areas provide the clearest and strongest support for an endangerment finding, both for current and future generations. Strong support is also found in the evidence concerning infrastructure and settlements, as well as ecosystems and wildlife. Across the sectors, the potential serious adverse impacts of extreme events, such as wildfires, flooding, drought, and extreme weather conditions provide strong support for such a finding.

Water resources across large areas of the country are at serious risk from climate change, with effects on water supplies, water quality, and adverse effects from extreme events such as floods and droughts. Even areas of the country where an increase in water flow is projected could face water resource problems from the supply and water quality problems associated with temperature increases and precipitation variability, and could face the increased risk of serious adverse effects from extreme events, such as floods and

drought. The severity of risks and impacts is likely to increase over time with accumulating greenhouse gas concentrations and associated temperature increases and precipitation changes.

Overall, the evidence on risk of adverse impacts for coastal areas provides clear support for a finding that greenhouse gas air pollution endangers the welfare of current and future generations. The most serious potential adverse effects are the increased risk of storm surge and flooding in coastal areas from sea level rise and more intense storms. Observed sea level rise is already increasing the risk of storm surge and flooding in some coastal areas. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. Even if there is a low probability of increasing the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution. In addition, coastal areas face other adverse impacts from sea level rise such as land loss due to inundation, erosion, wetland submergence, and habitat loss. The increased risk associated with these adverse impacts also endangers public welfare, with an increasing risk of greater adverse impacts in the future.

Strong support for an endangerment finding is also found in the evidence concerning energy, infrastructure, and settlements, as well ecosystems and wildlife. While the impacts on net energy demand may be viewed as generally neutral for purposes of making an endangerment determination, climate change is expected to result in an increase in electricity production, especially to meet peak demand. This increase may be exacerbated by the potential for adverse impacts from climate change on hydropower resources as well as the potential risk of serious adverse effects on energy infrastructure from extreme events. Changes in extreme weather events threaten energy, transportation, and water resource infrastructure. Vulnerabilities of industry, infrastructure, and settlements to climate change are generally greater in high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Climate

change will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles. Over the 21st century, changes in climate will cause some species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will likely alter ecosystem structure, function, and services, leading to predominantly negative consequences for biodiversity and the provision of ecosystem goods and services.

With respect to food production and agriculture, there is a potential for a net benefit in the near term for certain crops, but there is significant uncertainty about whether this benefit will be achieved given the various potential adverse impacts of climate change on crop yield, such as the increasing risk of extreme weather events. Other aspects of this sector may be adversely affected by climate change, including livestock management and irrigation requirements, and there is a risk of adverse effect on a large segment of the total crop market. For the near term, the concern over the potential for adverse effects in certain parts of the agriculture sector appears generally comparable to the potential for benefits for certain crops. However, the body of evidence points towards increasing risk of net adverse impacts on U.S. food production and agriculture over time, with the potential for significant disruptions and crop failure in the future.

For the near term, the Administrator finds the beneficial impact on forest growth and productivity in certain parts of the country from elevated carbon dioxide concentrations and temperature increases to date is offset by the clear risk from the observed increases in wildfires, combined with risks from the spread of destructive pests and disease. For the longer term, the risk from adverse effects increases over time, such that overall climate change presents serious adverse risks for forest productivity. There is compelling reason to find that the support for a positive endangerment finding increases as one considers expected future conditions where temperatures continue to rise.

Looking across all of the sectors discussed above, the evidence provides compelling support for finding that

greenhouse gas air pollution endangers the public welfare of both current and future generations. The risk and the severity of adverse impacts on public welfare are expected to increase over time.

h. Impacts in Other World Regions That Can Affect the U.S. Population

While the finding of endangerment to public health and welfare discussed above is based on impacts in the United States, the Administrator also considered how human-induced climate change in other regions of the world may in turn affect public welfare in the United States. According to the USGCRP report of June 2009 and other sources, climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade, and national security issues for the United States.³² The IPCC identifies the most vulnerable world regions as the Arctic, because of the effects of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea-level rise and increased storm surge; and Asian mega-deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge, and river flooding. Climate change has been described as a potential threat multiplier with regard to national security issues.

The Administrator acknowledges these kinds of risks do not readily lend themselves to precise analyses or future projections. However, given the unavoidable global nature of the climate change problem, it is appropriate and prudent to consider how impacts in other world regions may present risks to the U.S. population. Because human-induced climate change has the potential to aggravate natural resource, trade, and humanitarian issues in other world regions, which in turn may contribute to the endangerment of public welfare in the United States, this provides additional support for the Administrator's finding that the greenhouse gas air pollution is reasonably anticipated to endanger the public welfare of current and future

³² "In an increasingly interdependent world, U.S. vulnerability to climate change is linked to the fates of other nations. For example, conflicts or mass migrations of people resulting from food scarcity and other resource limits, health impacts or environmental stresses in other parts of the world could threaten U.S. national security." (Karl *et al.*, 2009).

generations of the United States population.

i. Summary of Key Public Comments on Endangerment to Public Welfare

Several public commenters point out the anticipated benefits that increasing carbon dioxide levels and temperatures will have on agricultural crops. In addition, commenters note how U.S. agricultural productivity, in particular, has been steadily rising over the last 100 years. Responses to major comments are found here and more detailed responses are found in the Response to Comments document.

The Administrator acknowledges that plants including agricultural crops respond to carbon dioxide positively based on numerous well-documented studies. However, previous assessments of food production and agriculture have been modified to highlight increasing vulnerability, stress, and adverse impacts from climate change over time, based on improvements in the understanding of plant physiology, concern over impacts on plant pests and pathogens, and the implications of changes in average temperatures for temperature extremes and for changes in the patterns of precipitation and evaporation. While it is still the case today and for the next few years that climate change benefits agriculture in some places and harms them in others, the Administrator considers that the far larger temperature increases expected over coming decades and beyond on the "business as usual" trajectory will put significant stresses on agriculture and land resources in all regions of the United States. The Administrator prudently considers increased climate variability associated with a warming climate, which may overwhelm the positive plant responses from elevated carbon dioxide over time. Further, the effects of climate change on weeds, insect pests, and pathogens are recognized as key factors in determining plant damage in future decades. The Administrator also notes that scientific literature clearly supports the finding that drought frequency and severity are projected to increase in the future over much of the United States, which will likely reduce crop yields because of excesses or deficits of water. Vulnerability to extended drought, according to IPCC, has been documented as already increasing across North America. Further, based on review of the assessment literature, the Administrator considers multiple stresses, such as limited availability of water resources, loss of biodiversity, and air pollution, which are likely to increase sensitivity and reduce

resilience in the agricultural sector to climate change over time.

Similar to food production and agriculture, public commenters often noted that forest productivity is projected to increase in the coming years due to the direct stimulatory effect of carbon dioxide on plant growth combined with warmer temperatures and thus extended growing seasons. The Administrator notes this phenomenon has been well documented by numerous studies but recognizes that increased productivity will be associated with significant variation at local and regional scales. The Administrator considers that climate strongly influences forest productivity and composition, and the frequency and magnitude of disturbances that impact forests. Based on the most recent IPCC assessment of the scientific literature, several recent studies confirm previous findings that temperature and precipitation changes in future decades will modify, and often limit, direct carbon dioxide effects on plants. For example, increased temperatures may reduce carbon dioxide effects indirectly, by increasing water demand. The Administrator also considers that new research more firmly establishes the negative impacts of increased climate variability. Projected changes in the frequency and severity of extreme climate events have significant consequences for forestry production and amplify existing stresses to land resources in the future.

Several public commenters maintain that wildfires are primarily the result of natural climatic factors and not climate change and dispute that they are or will increase in the future. The Administrator notes the scientific literature and assessment reports provide several lines of evidence that suggest wildfires will likely increase in frequency over the next several decades because of climate warming. Wildfires and droughts, among other extreme events (e.g., hurricanes) that cause forest damage, pose the largest threats over time to forest ecosystems. The assessment literature suggests that large, stand-replacing wildfires will likely increase in frequency over the next several decades because of climate warming and general climate warming encourages wildfires by extending the summer period that dries fuels, promoting easier ignition and faster spread. Furthermore, current climate modeling studies suggest that increased temperatures and longer growing seasons will elevate wildfire risk in connection with increased aridity.

V. The Administrator's Finding That Emissions of Greenhouse Gases From CAA Section 202(a) Sources Cause or Contribute to the Endangerment of Public Health and Welfare

As discussed in Section IV.A of these Findings, the Administrator is defining the air pollution for purposes of the endangerment finding to be the elevated concentration of well-mixed greenhouse gases in the atmosphere. The second step of the two-part endangerment test is for the Administrator to determine whether the emission of any air pollutant emitted from new motor vehicles cause or contribute to this air pollution. This is referred to as the cause or contribute finding, and is the second finding by the Administrator in this action.

Section V.A of these Findings describes the Administrator's definition and scope of the air pollutant "well-mixed greenhouse gases." Section V.B of these Findings puts forth the Administrator's finding that emissions of well-mixed greenhouse gases from new motor vehicles contribute to the air pollution which is reasonably anticipated to endanger public health and welfare. Section V.C of these Findings provides responses to some of the key comments on these issues. See Response to Comments document Volume 10 for responses to other significant comments on the cause or contribute finding. More detailed emissions data summarized in the discussion below can be found in Appendix B of the TSD.

A. The Administrator's Definition of the "Air Pollutant"

As discussed in the Proposed Findings, to help appreciate the distinction between air pollution and air pollutant, the *air pollution* can be thought of as the total, cumulative stock in the atmosphere, while the *air pollutant*, can be thought of as the flow that changes the size of the total stock. Given this relationship, it is not surprising that the Administrator is defining the air pollutant similar to the air pollution; while the air pollution is the concentration (e.g., stock) of the well-mixed greenhouse gases in the atmosphere, the air pollutant is the same combined grouping of the well-mixed greenhouse gases, the emissions of which are analyzed for contribution (e.g., the flow into the stock).

Thus, the Administrator is defining the air pollutant as the aggregate group of the same six long-lived and directly-emitted greenhouse gases: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons,

and sulfur hexafluoride. As noted above, this definition of a single air pollutant made up of these well-mixed greenhouse gases is similar to definitions of other air pollutants that are comprised of substances that share common attributes with similar effects on public health or welfare (e.g., particulate matter and volatile organic compounds).

The common attributes shared by these six greenhouse gases are discussed in detail in Section IV.A of these Findings, where the Administrator defined the "air pollution" for purposes of the endangerment finding. These same common attributes support the Administrator grouping these six greenhouse gases for purposes of defining a single air pollutant as well. These attributes include the fact that they are all greenhouse gases that are directly emitted (i.e., they are not formed through secondary processes in the atmosphere from precursor emissions); they are sufficiently long-lived in the atmosphere such that, once emitted, concentrations of each gas become well mixed throughout the entire global atmosphere; and they exert a climate warming effect by trapping outgoing, infrared heat that would otherwise escape to space. Moreover, the radiative forcing effect of these six greenhouse gases is well understood.

Furthermore, these six greenhouse gases are currently the common focus of climate science and policy. For example, the UNFCCC, signed and ratified by the U.S. in 1992, requires its signatories to "develop, periodically update, publish and make available * * * national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol³³, using comparable methodologies * * *"³⁴ To date, the focus of UNFCCC actions and discussions has been on the six greenhouse gases that are the same focus of these findings. As a Party to the UNFCCC, EPA annually submits the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* to the Convention, which reports on national emissions of anthropogenic emissions of the well-mixed greenhouse gases. International discussions about a post-Kyoto agreement also focus on the well-mixed greenhouse gases.

³³ The Montreal Protocol covers ozone-depleting substances which may also share physical attributes of the six key greenhouse gases in this action, but they do not share other attributes such as being the focus of climate science and policy. See section * * *.

³⁴ UNFCCC Art. 4.1(b).

As noted above, grouping of many substances with common attributes as a single pollutant is common practice under the CAA. Thus, doing so here is not novel. Indeed CAA section 302(g) defines air pollutant as "any air pollutant agent or combination of such agents, * * *" CAA § 302(g) (emphasis added). Thus, it is clear that the term "air pollutant" is not limited to individual chemical compounds. In determining that greenhouse gases are within the scope of this definition, the Supreme Court described section 302(g) as a "sweeping" and "capacious" definition that unambiguously included greenhouse gases, that are "unquestionably 'agents' of air pollution." *Massachusetts v. EPA*, 549 U.S. at 528, 532, 529 n.26. Although the Court did not interpret the term "combination of" air pollution agents, there is no reason this phrase would be interpreted any less broadly. Congress used the term "any", and did not qualify the kind of combinations that the agency could define as a single air pollutant. Congress provided EPA broad discretion to determine appropriate combinations of compounds that should be treated as a single air pollutant.³⁵

For the same reasons discussed in Section IV.A above, at this time, only carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride share all of these common attributes and thus they are the only substances that the Administrator finds to meet the definition of "well-mixed greenhouse gas" at this time.³⁶ Also as noted above, if in the future other substances are shown to meet the same criteria they may be added to the definition of this single air pollutant.

The Administrator is aware that CAA section 202(a) source categories do not emit all of the substances meeting the definition of well-mixed greenhouse gases. But that does not change the fact that all of these greenhouse gases share the attributes that make grouping them as a single air pollutant reasonable. As discussed further below, the reasonableness of this grouping does not turn on the particular source category

³⁵ Indeed, the greenhouse gases hydrofluorocarbons and perfluorocarbons each are already a combination of multiple compounds.

³⁶ The term "well-mixed greenhouse gases" is based on one of the shared attributes discussed above—these greenhouse gases are sufficiently long-lived in the atmosphere such that, once emitted, concentrations of each gas become well mixed throughout the entire global atmosphere. Defining the air pollutant to be the combination of these six well-mixed greenhouse gases is based in part on this attribute—after the gases are emitted, they are sufficiently long-lived in the atmosphere to become well mixed as part of the air pollution.

being evaluated in a contribution finding.

B. The Administrator's Finding Regarding Whether Emissions of the Air Pollutant From Section 202(a) Source Categories Cause or Contribute to the Air Pollution That May Be Reasonably Anticipated To Endanger Public Health and Welfare

The Administrator finds that emissions of the well-mixed greenhouse gases from new motor vehicles contribute to the air pollution that may reasonably be anticipated to endanger public health and welfare. This contribution finding is for all of the CAA section 202(a) source categories and the Administrator considered emissions from all of these source categories. The relevant mobile sources under CAA section 202 (a)(1) are "any class or classes of new motor vehicles or new motor vehicle engines, * * *," CAA section 202(a)(1) (emphasis added). The new motor vehicles and new motor vehicle engines (hereinafter "CAA section 202(a) source categories") addressed are: Passenger cars, light-duty trucks, motorcycles, buses, and medium and heavy-duty trucks. Detailed combined greenhouse gas emissions data for CAA section 202(a) source categories are presented in Appendix B of the TSD.³⁷

The Administrator reached her decision after reviewing emissions data on the contribution of CAA section 202(a) source categories relative to both global greenhouse gas emissions and U.S. greenhouse gas emissions. Given that CAA section 202(a) source categories are responsible for about 4 percent of total global greenhouse gas emissions, and for just over 23 percent of total U.S. greenhouse gas emissions, the Administrator finds that both of these comparisons, independently and together, support a finding that CAA section 202(a) source categories contribute to the air pollution that may be reasonably anticipated to endanger public health and welfare. The Administrator is not placing primary weight on either approach; rather she finds that both approaches clearly establish that emissions of the well-mixed greenhouse gases from section 202(a) source categories contribute to air pollution with may reasonably be anticipated to endanger public health and welfare. As the Supreme Court noted, "[j]udged by any standard, U.S.

³⁷ For section 202(a) source categories, only the hydrofluorocarbon emissions related to passenger compartment cooling are included. Emissions from refrigeration units that may be attached to trucks are considered emissions from nonroad engines under CAA section 213.

motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming." *Massachusetts v. EPA*, 549 U.S. at 525.³⁸

1. Administrator's Approach in Making This Finding

Section 202(a) of the CAA source categories consist of passenger cars, light-duty trucks, motorcycles, buses, and heavy- and medium-duty trucks. As noted in the Proposed Findings, in the past the requisite contribution findings have been proposed concurrently with proposing emission standards for the relevant mobile source category. Thus, prior contribution findings often focused on a subset of the CAA section 202(a) (or other section) source categories. This final cause or contribute finding, however, is for all of the CAA section 202(a) source categories. The Administrator is considering emissions from all of these source categories in the determination.

Section 202(a) source categories emit the following well-mixed greenhouse gases: carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons. As the basis for the Administrator's determination, EPA analyzed historical data of emissions of the well-mixed greenhouse gases for motor vehicles and motor vehicle engines in the United States from 1990 to 2007.

The Proposed Findings discussed a number of possible ways of assessing cause or contribute and the point was made that no single approach is required by the statute or has been used exclusively in previous determinations under the CAA. The Administrator also discussed how, consistent with prior cause or contribute findings and the science, she is using emissions as a proxy for contributions to atmospheric concentrations. This approach is reasonable for the well-mixed greenhouse gases, because cumulative emissions are responsible for the cumulative change in the concentrations in the atmosphere. Similarly, annual emissions are a perfectly reasonable proxy for annual incremental changes in atmospheric concentrations.

In making a judgment about the contribution of emissions from CAA section 202(a) source categories, the Administrator focused on making a reasoned overall comparison of emissions from the CAA section 202(a) source categories to emissions from

other sources of greenhouse gases. This allows a determination of how the CAA section 202(a) source categories compare to all of the other sources that together as a group make up the total emissions contributors to the air pollution problem. The relative importance of the CAA section 202(a) source categories is central to making the contribution determination. Both the magnitude of these emissions and the comparison of these emissions to other sources provide the basis to determine whether the CAA section 202(a) source categories may reasonably be judged as contributing to the air pollution problem.

In many cases EPA makes this kind of comparison of source categories by a simple percentage calculation that compares the emissions from the source category at issue to a larger total group of emissions. Depending on the circumstances, a larger percentage often means a greater relative impact from that source category compared to the other sources that make up the total of emissions, and vice versa. However, the actual numerical percentages may have little meaning when viewed in isolation. The context of the comparison is needed to ensure the information is useful in evaluating the relative impact of one source compared to others. For example, the number of sources involved and the distribution of emissions across all of the sources can make a significant difference when evaluating the results of a percentage calculation. In some cases a certain percentage might mean almost all other sources are larger or much larger than the source at issue, while in other circumstances the same percentage could mean that the source at issue is in fact one of the larger contributors to the total.

The Administrator therefore considered the totality of the circumstances in order to best understand the role played by CAA section 202(a) source categories. This is consistent with Congress' intention for EPA to consider the cumulative impact of all sources of pollution. In that context, the global nature of the air pollution problem and the breadth of countries and sources emitting greenhouse gases means that no single country and no single source category dominate or are even close to dominating on a global scale. For example, the United States as a country is the second largest emitter of greenhouse gases, and emits approximately 18 percent of the world's total greenhouse gases. The total emissions of greenhouse gases worldwide are from numerous sources and countries, with each country and

each source category contributing a relatively small percentage of the total emissions. That means that the relative ranking of countries or sources is not at all obvious from the magnitude of the percentage by itself. A country or a source may be a large contributor, in comparison to other countries or sources, even though its percentage contribution may appear relatively small.

In this situation, addressing a global air pollution problem may call for many different sources and countries to address emissions even if none by itself dominates or comes close to dominating the global inventory. A somewhat analogous situation can be found in the ozone air pollution problem in the United States. Emissions of NO_x and volatile organic compounds (VOCs) often come from numerous small sources, as well as certain large source categories. We have learned that successful ozone control strategies often need to take this into account, and address both the larger sources of NO_x and VOCs as well as the many smaller sources, given the breadth of sources that as a group lead to the total inventory of VOCs and NO_x.

The global aspects of the greenhouse gas air pollution problem amplify this kind of situation many times over, where no single country or source category dominates or comes close to dominating the global inventory of greenhouse gas emissions. These unique, global aspects of the climate change problem tend to support consideration of contribution at lower percentage levels of emissions than might otherwise be considered appropriate when addressing a more typical local or regional air pollution problem. In this situation it is quite reasonable to consider emissions from source categories that are more important in relation to other sources, even if their absolute contribution initially may appear to be small.

In addition, the Administrator is aware of the fact that the United States is the second largest emitter of well-mixed greenhouse gases in the world. As the United States evaluates how to address climate change, the Administrator will analyze the various sources of emissions and the source's share of U.S. emissions. Thus, when analyzing whether a source category that emits well-mixed greenhouse gases in the United States contributes to the global problem, it is appropriate for the Administrator to consider how that source category fits into the larger picture of U.S. emissions. This ranking process within the United States allows the importance of the source category to

³⁸ Because the Administrator is defining the air pollutant as the combination of well-mixed greenhouse gases, she is not issuing a final contribution finding based on the alternative definition discussed in the proposed findings (e.g., each greenhouse gas as an individual air pollutant).

be seen compared to other U.S. sources, informing the judgment of the importance of emissions from this source category in any overall national strategy to address greenhouse gas emissions.

It is in this broader context that EPA considered the contribution of CAA section 202(a) sources. This provides useful information in determining the importance that should be attached to the emissions from the CAA section 202(a) sources.

In reaching her determination, the Administrator used two simple and straightforward comparisons to assess cause or contribute for CAA section 202(a) source categories: (1) As a share of total current global aggregate emissions of the well-mixed greenhouse gases; and (2) as a share of total current U.S. aggregate emissions of the well-mixed greenhouse gases.

Total well-mixed greenhouse gas emissions from CAA section 202(a) source categories were compared to total global emissions of the well-mixed greenhouse gases. The total air pollution problem, as already discussed, is the elevated and climbing levels of the six greenhouse gas concentrations in the atmosphere, which are global in nature because these concentrations are globally well mixed (whether they are emitted from CAA section 202(a) source categories or any other source within or outside the United States). In addition, comparisons were also made to U.S. total well-mixed greenhouse gas emissions to appreciate how CAA section 202(a) source categories fit into

the larger U.S. contribution to the global problem. It is typical for the Administrator to consider these kinds of comparisons of emissions of a pollutant in evaluating contribution to air pollution, such as the concentrations of that same pollutant in the atmosphere (e.g., the Administrator analyzes PM_{2.5} emissions to determine if a source category contributes to PM_{2.5} air pollution). When viewed in the circumstances discussed above, both of these comparisons provide useful information in determining whether these source categories should be judged as contributing to the total air pollution problem.

a. Section 202(a) of the CAA—Share of Global Aggregate Emissions of the Well-Mixed Greenhouse Gases

Global emissions of well-mixed greenhouse gases have been increasing, and are projected to continue increasing unless the major emitters take action to reduce emissions. Total global emissions of well-mixed greenhouse gases in 2005 (the most recent year for which data for all countries and all greenhouse gases are available)³⁹ were 38,726 teragrams of CO₂-equivalent (TgCO₂eq.)⁴⁰ This represents an increase in global greenhouse gas emissions of about 26 percent since 1990 (excluding land use, land use change and forestry). In 2005, total U.S. emissions of well-mixed greenhouse gases were responsible for 18 percent of global emissions, ranking only behind China, which was responsible for 19

percent of global emissions of well-mixed greenhouse gases.

In 2005 emissions of the well-mixed greenhouse gas pollutant from CAA section 202(a) source categories represented 4.3 percent of total global well-mixed greenhouse gas emissions and 28 percent of global transport well-mixed greenhouse gas emissions (Table 1 of these Findings). If CAA section 202(a) source categories' emissions of well-mixed greenhouse gas were ranked against total well-mixed greenhouse gas emissions for entire countries, CAA section 202(a) source category emissions would rank behind only China, the United States as a whole, Russia, and India, and would rank ahead of Japan, Brazil, Germany and every other country in the world. Indeed, countries with lower emissions than the CAA section 202(a) source categories are members of the 17 "major economies" "that meet to advance the exploration of concrete initiatives and joint ventures that increase the supply of clean energy while cutting greenhouse gas emissions." See <http://www.state.gov/g/oes/climate/mem/>. It would be anomalous, to say the least, to consider Japan and these other countries as major players in the global climate change community and an integral part of the solution, but not find that CAA section 202(a) source category emissions contribute to the global problem. Thus, the Administrator finds that emission of well-mixed greenhouse gases from CAA section 202(a) source categories contribute to the air pollution of well-mixed greenhouse gases.

TABLE 1—COMPARISON TO GLOBAL GREENHOUSE GAS (GHG) EMISSIONS (Tg CO₂E)

	2005	Sec 202(a) share (percent)
All U.S. GHG emissions	7,109	23.5
Global transport GHG emissions	5,968	28.0
All global GHG emissions	38,726	4.3

b. Section 202(a) of the CAA—Share of U.S. Aggregate Emissions of the Well-Mixed Greenhouse Gases

The Administrator considered compared total emissions of the well-mixed greenhouse gases from CAA section 202(a) source categories to total

³⁹ The source of global greenhouse gas emissions data, against which comparisons are made, is the Climate Analysis Indicators Tool of the World Resources Institute (WRI) (2007). Note that for global comparisons, all emissions are from the year 2005, the most recent year for which data for all greenhouse gas emissions and all countries are available. WRI (2007) Climate Analysis Indicators Tool (CAIT). Available at <http://cait.wri.org>. Accessed August 5, 2009.

U.S. emissions of the well-mixed greenhouse gases as an indication of the role these sources play in the total U.S. contribution to the air pollution problem causing climate change.⁴¹

In 2007, U.S. well-mixed greenhouse gas emissions were 7,150 TgCO₂eq. The dominant gas emitted was carbon

⁴⁰ One teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kg = 2,205 lbs. Long-lived greenhouse gases are compared and summed together on a CO₂ equivalent basis by multiplying each gas by its Global Warming Potential (GWP), as estimated by IPCC. In accordance with UNFCCC reporting procedures, the U.S. quantifies greenhouse gas emissions using the 100-year time frame values for GWPs established in the IPCC Second Assessment Report.

dioxide, mostly from fossil fuel combustion. Methane was the second largest well-mixed greenhouse gas, followed by N₂O, and the fluorinated gases (HFCs, PFCs, and SF₆). Electricity generation was the largest emitting sector (2,445 TgCO₂eq or 34 percent of

⁴¹ Greenhouse gas emissions data for the United States in this section have been updated since the Proposed Findings to reflect EPA's most up-to-date information, which includes data for the year 2007. The source of the U.S. greenhouse gas emissions data is the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007*, published in 2009 (hereinafter "U.S. Inventory").

total U.S. greenhouse gas emissions), followed by transportation (1,995 TgCO₂eq or 28 percent) and industry (1,386 TgCO₂eq or 19 percent). Emissions from the CAA section 202(a) source categories constitute the major part of the transportation sector. Land use, land use change, and forestry offset almost 15 percent of total U.S. emissions through net sequestration. Total U.S. well-mixed greenhouse gas emissions have increased by over 17 percent between 1990 and 2007. The electricity generation and transportation sectors have contributed the most to this increase.

In 2007 emissions of well-mixed greenhouse gases from CAA section 202(a) source categories collectively were the second largest emitter of well-mixed greenhouse gases within the United States (behind the electricity generating sector), emitting 1,663 TgCO₂eq and representing 23 percent of total U.S. emissions of well-mixed greenhouse gases (Table 2 of these Findings). The Administrator is keenly aware that the United States is the second largest emitter of well-mixed greenhouse gases. Part of analyzing whether a sector within the United States contributes to the global problem is to see how those emissions fit into the

contribution from the United States as a whole. This informs her judgment as to the importance of emissions from this source category in any overall national strategy to address greenhouse gas emissions. Thus, it is relevant that CAA section 202(a) source categories are the second largest emitter of well-mixed greenhouse gases in the country. This is part of the Administrator looking at the totality of the circumstances. Based on this the Administrator finds that emission of well-mixed greenhouse gases from CAA section 202(a) source categories contribute to the air pollution of well-mixed greenhouse gases.

TABLE 2—SECTORAL COMPARISON TO TOTAL U.S. GREENHOUSE GAS (GHG) EMISSIONS (Tg CO₂E)

U.S. emissions	1990	1995	2000	2005	2006	2007
Section 202(a) GHG emissions	1231.9	1364.4	1568.1	1670.5	1665.7	1663.1
Share of U.S. (%)	20.2%	21.1%	22.4%	23.5%	23.6%	23.3%
Electricity Sector emissions	1859.1	1989.0	2329.3	2429.4	2375.5	2445.1
Share of U.S. (%)	30.5%	30.8%	33.2%	34.2%	33.7%	34.2%
Industrial Sector emissions	1496.0	1524.5	1467.5	1364.9	1388.4	1386.3
Share of U.S. (%)	24.5%	23.6%	20.9%	19.2%	19.7%	19.4%
Total U.S. GHG emissions	6098.7	6463.3	7008.2	7108.6	7051.1	7150.1

C. Response to Key Comments on the Administrator's Cause or Contribute Finding

EPA received numerous public comments regarding the Administrator's proposed cause or contribute finding. Below is a brief discussion of some of the key comments. Responses to comments on this issue are also contained in the Response to Comments document, Volume 10.

1. The Administrator Reasonably Defined the "Air Pollutant" for the Cause or Contribute Analysis

a. The Supreme Court Held that Greenhouse Gases Fit Within the Definition of "Air Pollutant" in the CAA

Several commenters reiterate arguments already rejected by the Supreme Court, arguing that greenhouse gases do not fit into the definition of "air pollutant" under the CAA. In particular, at least one commenter contends that EPA must show how greenhouse gases impact or materially change "ambient air" when defining air pollutant and making the endangerment finding. This commenter argues that because carbon dioxide is a naturally occurring and necessary element in the atmosphere, it cannot be considered to materially change air.

These and similar arguments were already rejected by the Supreme Court in *Massachusetts v. EPA*, 549 U.S. 497 (2007). Briefs before the Supreme Court

also argued that carbon dioxide is an essential role for life on earth and therefore cannot be considered an air pollutant, and that the concentrations of greenhouse gases that are a potential problem are not in the "ambient air" that people breathe.

The Court rejected all of these and other arguments, noting that the statutory text forecloses these arguments. "The Clean Air Act's sweeping definition of 'air pollutant' includes 'any air pollution agent or combination of such agents, including any physical, chemical * * * substance or matter which is emitted into or otherwise enters the ambient air. * * *' § 7602(g) (emphasis added). On its face, the definition embraces all airborne compounds of whatever stripe, and underscores that intent through the repeated use of the word 'any.' Carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons are without a doubt 'physical [and] chemical * * * substance[s] which [are] emitted into * * * the ambient air.' The statute is unambiguous."

547 U.S. at 529-30 (footnotes omitted); see also *id.* at 530, n26 (the distinction regarding ambient air, however, finds no support in the text of the statute, which uses the phrase "the ambient air" without distinguishing between atmospheric layer.). Thus, the question of whether greenhouse gases fit within the definition of air pollutant

under the CAA has been decided by the Supreme Court and is not being revisited here.

b. The Definition of Air Pollutant May Include Substances Not Emitted by CAA Section 202(a) Sources

Many commenters argue that the definition of "air pollutant"—here well-mixed greenhouse gases—cannot include PFCs and SF₆ because they are not emitted by CAA section 202(a) motor vehicles and hence, cannot be part of any "air pollutant" emitted by such sources. They argue that by improperly defining "air pollutant" to include substances that are not present in motor vehicle emissions, the Agency has exceeded its statutory authority under CAA section 202(a). Commenters contend that past endangerment findings under CAA section 202(a) demonstrate EPA's consistent approach of defining "air pollutant(s)" in accordance with the CAA's clear direction, to include only those pollutants emitted from the relevant source category (citing Notice of Proposed Rulemaking for Heavy-Duty Engine and Vehicle Standards finding that "emissions of NO_x, VOCs, SO_x, and PM from heavy-duty trucks can reasonably be anticipated to endanger the public health or welfare." (65 FR 35436, June 2, 2000)). Commenters argue that EPA itself is inconsistent in the Proposed Findings, sometimes referring

to "air pollutant" as the group of six greenhouse gases, and other times falling back on the four greenhouse gases emitted by motor vehicles.

EPA acknowledges that the Proposed Findings could have been clearer regarding the proposed definition of air pollutant, and how it was being applied to CAA section 202(a) sources, which emit only four of the six substances that meet the definition of well-mixed greenhouse gases. However, our interpretation does not exceed EPA's authority under CAA section 202(a). It is reasonable to define the air pollutant under CAA section 202(a) to include substances that have similar attributes (as discussed above), even if not all of the substances that meet that definition are emitted by motor vehicles. For example, as commenters note, EPA has heavy duty truck standards applicable to VOCs and PM, but it is highly unlikely that heavy duty trucks emit every substance that is included in the group defined as VOC or PM. See 40 CFR 51.100(s) (defining volatile organic compound (VOC) as "any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions", a list of exemptions are also included in the definition); 40 CFR 51.100(o) (defining particulate matter (PM) as "any airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 100 micrometers").

In this circumstance the number of substances included in the definition of well-mixed greenhouse gases is much smaller than other "group" air pollutants (e.g., six greenhouse gases versus hundreds of VOCs), and CAA section 202(a) sources emit an easily discernible number of these six substances. However, this does not mean that the definition of the well-mixed greenhouse gases as the air pollutant is unreasonable. By defining well-mixed greenhouse gases as a single air pollutant comprised of six substances with common attributes, the Administrator is giving effect to these shared attributes and how they are relevant to the air pollution to which they contribute. The fact that these six substances share these common, relevant attributes is true regardless of the source category being evaluated for contribution. Grouping these six substances as one air pollutant is reasonable regardless of whether a contribution analysis is undertaken for CAA section 202(a) sources that emit one subset of the six substances (e.g., carbon dioxide, CH₄, N₂O and HFCs, but

not PFCs and SF₆), or for another category of sources that may emit another subset. For example, electronics manufacturers that may emit N₂O, PFCs, HFCs, SF₆ and other fluorinated compounds, but not carbon dioxide or CH₄, unless there is on-site fuel combustion. In other words, it is not necessarily the source category being evaluated for contribution that determines the reasonableness of defining a group air pollutant based on the shared attributes of the group.

Even if EPA agreed with commenters, and defined the air pollutant as the group of four compounds emitted by CAA section 202(a) sources, it would not change the result. The Administrator would make the same contribution finding as it would have no material effect on the emissions comparisons discussed above.

c. It Was Reasonable for the Administrator To Define the Single Air Pollutant as the Group of Substances With Common Attributes

Several commenters disagree with EPA's proposed definition of a single air pollutant composed of the six well-mixed greenhouse gases as a class. Commenters argue that the analogy to VOCs is misplaced because VOCs are all part of a defined group of chemicals, for which there are established quantification procedures, and for which there were extensive data showing that the group of compounds had demonstrated and quantifiable effects on ambient air and human health and welfare, and for which verifiable dispersion models existed. They contend this is in stark contrast to the entirely diverse set of organic and inorganic compounds EPA has lumped together for purposes of the Proposed Findings, and for which no model can accurately predict or quantify the actual impact or improvement resulting from controlling the compounds. Moreover, they argue that the gases EPA is proposing to list together as one pollutant are all generated by different processes and, if regulated, would require different types of controls; the four gases emitted by mobile sources can generally be limited only by using controls that are specific to each.

At least one commenter argues that EPA cannot combine greenhouse gases into one pollutant because their common attribute is not a "physical, chemical, biological or radioactive property" (quoting from CAA section 302(g)), but rather their effect or impacts on the environment. They say this differs from VOCs, which share the common attribute of volatility, or PM

which shares the physical property of being particles.

As discussed above, the well-mixed greenhouse gases share physical attributes, as well as attributes based on sound policy considerations. The definition of "air pollutant" in CAA section 302(g) does not limit consideration of common attributes to those that are "physical, chemical, biological or radioactive property" as one commenter claims. Rather, the definition's use of the adjectives "physical, chemical, biological or radioactive" refer to the different types of substance or matter that is emitted. It is not a limitation on what characteristics the Administrator may consider when deciding how to group similar substances when defining a single air pollutant.

The common attributes that the Administrator considered when defining the well-mixed greenhouse gases are reasonable. While these six substances may originate from different processes, and require different control strategies, that does not detract from the fact that they are all long-lived, well-mixed in the atmosphere, directly emitted, of well-known radiative forcing, and generally grouped and considered together in climate change scientific and policy forums. Indeed, other group pollutants also originate from a variety of processes and a result may require different control technologies. For example, both a power plant and a dirt road can result in PM emissions, and the method to control such emissions at each source would be different. But these differences in origin or control do not undermine the reasonableness of considering PM as a single air pollutant. The fact that there are differences, as well as similarities, among the well-mixed greenhouse gases does not render the decision to group them together as one air pollutant unreasonable.

2. The Administrator's Cause or Contribute Analysis Was Reasonable

a. The Administrator Does Not Need To Find Significant Contribution, or Establish a Bright Line

Many commenters essentially argue that EPA must establish a bright line below which it would never find contribution regardless of the air pollutant, air pollution, and other factors before the Agency. For example, some commenters argue that EPA must provide some basis for determining de minimis amounts that fall below the threshold of "contributing" to the endangerment of public health and welfare under CAA section 202(a).

Commenters take issue with EPA's statement that it "need not determine at this time the circumstances in which emissions would be trivial or de minimis and would not warrant a finding of contribution." Commenters argue that EPA cannot act arbitrarily by determining that a constituent contributing a certain percent to endangerment in one instance is de minimis and in another is contributing to endangerment of public health and welfare. They request that EPA revise the preamble language to make clear that the regulated community can rely on its past determinations with respect to "contribution" determinations to predict future agency action and argue that EPA should promulgate guidance on how it determines whether a contribution exceeds a de minimis level for purposes of CAA section 202(a) before finalizing the proposal.

The commenters that argue that the air pollution EPA must analyze to determine endangerment is limited to the air pollution resulting from new motor vehicles also argue that as a result, the contribution of emissions from new motor vehicles must be significant. They essentially contend that the endangerment and cause or contribute tests are inter-related and the universe of both tests is the same. In support of their argument, commenters argue that because the clause "cause, or contribute to, air pollution" is in plural form, it must be referring back to "any class or classes of new motor vehicles or new motor vehicle engines," demonstrating that EPA must consider only the emissions from new motor vehicles which emit the air pollution which endangers.

Since the Administrator issued the Proposed Findings, the DC Circuit issued another opinion discussing the concept of contribution. See *Catawba County v. EPA*, 571 F.3d 20 (DC Cir. 2009). This decision, along with others, supports the Administrator's interpretation that the level of contribution under CAA section 202(a) does not need to be significant. The Administrator is not required to establish a bright line below which she would never find contribution under any circumstances. Finally, it is reasonable for the Administrator to apply a "totality-of-the-circumstances test to implement a statute that confers broad discretionary authority, even if the test lacks a definite 'threshold' or 'clear line of demarcation to define an open-ended term.'" *Id.* at 39 (citations omitted).

In upholding EPA's PM_{2.5} attainment and nonattainment designation decisions, the DC Circuit analyzed CAA

section 107(d), which requires EPA to designate an area as nonattainment if it "contributes to ambient air quality in a nearby area" not attaining the national ambient air quality standards. *Id.* at 35. The court noted that it had previously held that the term "contributes" is ambiguous in the context of CAA language. See *EDF v. EPA*, 82 F.3d 451, 459 (DC Cir. 1996). "[A]mbiguities in statutes within an agency's jurisdiction to administer are delegations of authority to the agency to fill the statutory gap in reasonable fashion." 571 F.3d at 35 (citing *Nat's Cable & Telecomms. Ass'n v. Brand X Internet Servs.*, 545 U.S. 967, 980 (2005)).

The court then proceeded to consider and reject petitioners' argument that the verb "contributes" in CAA section 107(d) necessarily connotes a significant causal relationship. Specifically, the DC Circuit again noted that the term is ambiguous, leaving it to EPA to interpret in a reasonable manner. In the context of this discussion, the court noted that "a contribution may simply exacerbate a problem rather than cause it * * * 571 F.3d at 39. This is consistent with the DC Circuit's decision in *Bluewater Network v. EPA*, 370 F.3d 1 (DC Cir. 2004), in which the court noted that the term contribute in CAA section 213(a)(3) "[s]tanding alone, * * * has no inherent connotation as to the magnitude or importance of the relevant 'share' in the effect; certainly it does not incorporate any 'significance' requirement." 370 F.3d at 13. The court found that the bare "contribute" language invests the Administrator with discretion to exercise judgment regarding what constitutes a sufficient contribution for the purpose of making an endangerment finding. *Id.* at 14.

Finally, in *Catawba County*, the DC Circuit also rejected "petitioners' argument that EPA violated the statute by failing to articulate a quantified amount of contribution that would trigger" the regulatory action. 571 F.3d at 39. Although petitioners preferred that EPA establish a bright-line test, the court recognized that the statute did not require that EPA "quantify a uniform amount of contribution." *Id.*

Given this context, it is entirely reasonable for the Administrator to interpret CAA section 202(a) to require some level of contribution that, while more than de minimis or trivial, does not rise to the level of significance. Moreover, the approach suggested by at least one commenter collapses the two prongs of the test by requiring that contribution must be significant because any climate change impacts upon which an endangerment determination is made result solely from the greenhouse gas

emissions of motor vehicles. It essentially eliminates the "contribute" part of the "cause or contribute" portion of the test. This approach was clearly rejected by the en banc court in *Ethyl*, 541 F.2d at 29 (rejecting the argument that the emissions of the fuel additive to be regulated must "in and of itself, *i.e.* considered in isolation, endanger[] public health."); see also *Catawba County*, 571 F.3d at 39 (noting that even if the test required significant contribution it would be reasonable for EPA to find a county's addition of PM_{2.5} is significant even though the problem would persist in its absence). It is the commenter, not EPA that is ignoring the statutory language. Whether or not the clause "cause, or contribute to, air pollution" refers back to "any class or classes of new motor vehicles or new motor vehicle engines," or to "emission of any air pollutant," the language of CAA section 202(a) clearly contemplates that emission of an air pollutant from any class or classes may merely contribute to, versus cause, the air pollution which endangers.

It is also reasonable for EPA to decline to establish a "bright-line 'objective' test of contribution." 571 F.3d at 39. As noted in the Proposed Findings, when exercising her judgment, the Administrator not only considers the cumulative impact, but also looks at the totality of the circumstances (e.g., the air pollutant, the air pollution, the nature of the endangerment, the type of source category, the number of sources in the source category, and the number and type of other source categories that may emit the air pollutant) when determining whether the emissions justify regulation under the CAA. *Id.* (It is reasonable for an agency to adopt a totality-of-the-circumstances test).

Even if EPA agreed that a level of significance was required to find contribution, for the reasons discussed above, EPA would find that the contribution from CAA section 202(a) source categories is significant. Their emissions are larger than the great majority of emitting countries, larger than several major emitting countries, and they constitute one of the largest parts of the U.S. emissions inventory.

b. The Unique Global Aspects of Climate Change Are an Appropriate Consideration in the Contribution Analysis

Some commenters disagree with statements in the Proposed Findings that the "unique, global aspects of the climate change problem tend to support a finding that lower levels of emissions should be considered to contribute to the air pollution than might otherwise

be appropriate when considering contribution to a local or regional air pollution problem." They argue there is no basis in the CAA or existing EPA policy for this position, and that it reveals an apparent effort to expand EPA's authority to the "truly trivial or de minimis" sources that are acknowledged to be outside the scope of regulation, in that it expands EPA's authority to regulate pollutants to address global effects.

Commenters also assert that contrary to EPA's position, lower contribution numbers are appropriate when looking at local pollution, like nonattainment concerns—in other words, in the context of a statutory provision like CAA section 213 specifically aimed at targeting small source categories to help nonattainment areas meet air quality standards. However, they conclude this policy is simply inapplicable in the context of global climate change.

As discussed above, the term "contribute" is ambiguous and subject to the Administrator's reasonable interpretation. It is entirely appropriate for the Administrator to look at the totality of the circumstances when making a finding of contribution. In this case, the Administrator believes that the global nature of the problem justifies looking at contribution in a way that takes account of these circumstances. More specifically, because climate change is a global problem that results from global greenhouse gas emissions, there are more sources emitting greenhouse gases (in terms both of absolute numbers of sources and types of sources) than EPA typically encounters when analyzing contribution towards a more localized air pollution problem. From a percentage perspective, there are no dominating sources and fewer sources that would even be considered to be close to dominating. The global problem is much more the result of numerous and varied sources each of which emit what might seem to be smaller percentage amounts when compared to the total. The Administrator's approach recognizes this reality, and focuses on evaluating the relative importance of the CAA section 202(a) source categories compared to other sources when viewed in this context.

This recognition of the unique totality of the circumstances before the Administrator now as compared to previous contribution decisions is entirely appropriate. It is not an attempt by the Administrator to regulate "truly trivial or de minimis" sources, or to regulate sources based on their global effects. The Administrator is determining whether greenhouse gas

emissions from CAA section 202(a) sources contribute to an air pollution problem is endangering U.S. public health and welfare. As discussed in the Proposed Findings, no single greenhouse gas source category dominates on the global scale, and many (if not all) individual greenhouse gas source categories could appear small in comparison to the total, when, in fact, they could be very important contributors in terms of both absolute emissions or in comparison to other source categories, globally or within the United States. If the United States and the rest of the world are to combat the risks associated with global climate change, contributors must do their part even if their contributions to the global problem, measured in terms of percentage, are smaller than typically encountered when tackling solely regional or local environmental issues. The commenters' approach, if used globally, would effectively lead to a tragedy of the commons, whereby no country or source category would be accountable for contributing to the global problem of climate change, and nobody would take action as the problem persists and worsens. The Administrator's approach, on the contrary, avoids this kind of approach, and is a reasonable exercise of her discretion to determine contribution in the global context in which this issue arises.

Importantly, as discussed above, the contribution from CAA section 202(a) sources is anything but trivial or de minimis under any interpretation of contribution. See, *Massachusetts v. EPA*, 549 U.S. at 1457–58 ("Judged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming").

c. The Administrator Reasonably Relied on Comparisons of Emissions From Existing CAA Section 202(a) Source Categories

i. It Was Reasonable To Use Existing Emissions From Existing CAA Section 202(a) Source Categories Instead of Projecting Future Emissions From New CAA Section 202(a) Source Categories

Many commenters argue that EPA improperly evaluated the emissions from the entire motor vehicle fleet, and it is required to limit its calculation to just emissions from new motor vehicles. Thus the emissions that EPA should consider in the cause or contribute determination is far less than the 4.3 percent of U.S. greenhouse gas emissions attributed to motor vehicles

in the Proposed Findings, because this number includes both new and existing motor vehicles. One commenter calculated the emissions from new motor vehicles as being 1.8 percent of global emissions, assuming approximately one year of new motor vehicle production in the United States (11 million vehicles) in a total global count currently of approximately 600 million motor vehicles.

In the Proposed Findings, EPA determined the emissions from the entire fleet of motor vehicles in the United States for a certain calendar year. EPA explained that, consistent with its traditional practice, it used the recent motor vehicle emissions inventory for the entire fleet as a surrogate for estimates of emissions for just new motor vehicles and engines. This was appropriate because future projected emissions are uncertain and current emissions data are a reasonable proxy for near-term emissions.

In effect, EPA is using the inventory for the current fleet of motor vehicles as a reasonable surrogate for a projection of the inventory from new motor vehicles over the upcoming years. New motor vehicles are produced year in and year out, and over time the fleet changes over to a fleet composed of such vehicles. This occurs in a relatively short time frame, compared to the time period at issue for endangerment. Because new motor vehicles are produced each year, and continue to emit over their entire life, over a relatively short period of time the emission from the entire fleet is from vehicles produced after a certain date. In addition, the emissions from new motor vehicles are not limited to the emissions that occur only during the one year when they are new, but are emissions over the entire life of the vehicle.

In such cases, EPA has traditionally used the recent emissions from the entire current fleet of motor vehicles as a reasonable surrogate for such a projection instead of trying to project and model those emissions. While this introduces some limited degree of uncertainty, the difference between recent actual emissions from the fleet and projected future emissions from the fleet is not expected to differ in any way that would substantively change the decision made concerning cause or contribution. There is not a specific numerical bright line that must be achieved, and the numerical percentages are not treated and do not need to be treated as precise values. This approach provides a reasonable and clear indication of the relative magnitudes involved, and EPA does not believe that attempting to make future

projections (for both vehicles and the emissions value they are compared to) would provide any greater degree of accuracy or precision in developing such a relative comparison.

ii. The Administrator Did Not Have To Use a Subset or Reduced Emissions Estimate From Existing CAA Section 202(a) Source Categories

Several commenters note that although EPA looks at emissions from all motor vehicles regulated under CAA section 202(a) in its contribution analysis, the Presidential announcement in May 2009 indicated that EPA was planning to regulate only a subset of 202(a) sources. Thus, they question whether the correct contribution analysis should look only at the emissions from that subset and not all CAA section 202(a) sources. Some commenters also argue that because emission standards will not eliminate all greenhouse gas emissions from motor vehicles, the comparison should compare the amount of greenhouse gas emissions "reduced" by those standards to the global greenhouse emissions. They also contend that the cost of the new standards will cause individual consumers, businesses, and other vehicle purchasers to hold on to their existing vehicles to a greater extent, thereby decreasing the amount of emissions reductions attributable to the standard and appropriately considered in the contribution analysis. Some commenters go further and contend that EPA also can only include that incremental reduction that the EPA regulations will achieve beyond any reductions resulting from CAFE standards that NHTSA will set.

Although the May announcement and September proposed rule involved only the light duty motor vehicle sector, the Administrator is making this finding for all classes of new motor vehicles under CAA section 202(a). Thus, although the announcement and proposed rule involve light duty vehicles, EPA is working to develop standards for the rest of the classes of new motor vehicles under CAA section 202(a). As the Supreme Court noted, EPA has "significant latitude as to the manner, timing, content, and coordination of its regulations with those of other agencies. *Massachusetts v. EPA*, 549 U.S. at 533.

The argument that the Administrator can only look at that portion of emissions that will be reduced by any CAA section 202(a) standards, and even then only the reduction beyond those attributable to CAFE rules, finds no basis in the statutory language. The language in CAA section 202(a) requires that the Administrator set "standards

applicable to the emission of any air pollutant from [new motor vehicles], which in [her] judgment cause, or contribute to, air pollution which [endangers]." It does not say set "standards applicable to the emission of any air pollutant from [new motor vehicles], if in [her] judgment the emissions of that air pollutant as reduced by that standard cause, or contribute to, air pollution which [endangers]." As discussed above, the decisions on cause or contribute and endangerment are separate and distinct from the decisions on what emissions standards to set under CAA section 202(a). The commenter's approach would improperly integrate these separate decisions. Indeed, because, as discussed above, the Administrator does not have to propose standards concurrent with the endangerment and cause or contribute findings, she would have to be prescient to know at the time of the contribution finding exactly the amount of the reduction that would be achieved by the standards to be set. As discussed above, for purposes of these findings we look at what would be the emissions from new motor vehicles if no action were taken. Current emissions from the existing CAA section 202(a) vehicle fleet are an appropriate estimate.

d. The Administrator Reasonably Compared CAA Section 202(a) Source Emissions to Both Global and Domestic Emissions of Well-Mixed Greenhouse Gases

EPA received many comments on the appropriate comparison(s) for the contribution analysis. Several commenters argue that in order to get around the "problem" of basing an endangerment finding upon a source category that contributes only 1.9 percent annually to global greenhouse gas emissions, EPA inappropriately also made comparisons to total U.S. greenhouse gas emissions. These commenters argue that a comparison of CAA section 202(a) source emissions to U.S. greenhouse gas emissions, versus global emissions, is arbitrary for purposes of the cause or contribute analysis, because it conflicts with the Administrator's definition of "air pollution," as well as the nature of global warming. They note that throughout the Proposed Findings, the Administrator focuses on the global nature of greenhouse gas. Thus, they continue, while the percentage share of motor vehicle emissions at the U.S. level may be relevant for some purposes, it is irrelevant to a finding of whether these emissions contribute to the air pollution, which the Administrator has proposed to define on

a global rather than a domestic basis. Commenters also accuse EPA of arbitrarily picking and choosing when it takes a global approach (e.g., endangerment finding) and when it does not (e.g., contribution findings).

The language of CAA section 202(a) is silent regarding how the Administrator is to make her contribution analysis. While it requires that the Administrator assess whether emission of an air pollutant contributes to air pollution which endangers, it does not limit how she may undertake that assessment. It surely is reasonable that the Administrator look at how CAA section 202(a) source category emissions compare to global emissions on an absolute basis, by themselves. But the United States as a nation is the second largest emitter of greenhouse gases. It is entirely appropriate for the Administrator to decide that part of understanding how a U.S. source category emitting greenhouse gases fits into the bigger picture of global climate change is to appreciate how that source category fits into the contribution from the United States as a whole, where the United States as a country is a major emitter of greenhouse gases. Knowing that CAA section 202(a) source categories are the second largest emitter of well-mixed greenhouse gases in the country is relevant to understanding what role they play in the global problem and hence whether they "contribute" to the global problem. Moreover, the Administrator is not "picking and choosing" when she applies a global or domestic approach in these Findings. Rather, she is looking at both of these emissions comparisons as appropriate under the applicable science, facts, and law.

e. The Amount of Well-Mixed Greenhouse Gas Emissions From CAA Section 202(a) Sources Reasonably Supports a Finding of Contribution

Many commenters argue that the "cause or contribute" prong of the Proposal's endangerment analysis fails to satisfy the applicable legal standard, which requires more than a minimal contribution to the "air pollution reasonably anticipated to endanger public health or welfare." They contend that emissions representing approximately four percent of total global greenhouse gas emissions are a minimal contribution to global greenhouse gas concentrations.

EPA disagrees. As stated above, CAA section 202(a) source category total emissions of well-mixed greenhouse gases are higher than most countries in the world; countries that the U.S. and others believe play a major role in the

global climate change problem. Moreover, the percent of global well-mixed greenhouse gas emissions that CAA section 202(a) source categories represent is higher than percentages that the EPA has found contribute to air pollution problems. See *Bluewater Network*, 370 F.3d at 15 (“For Fairbanks, this contribution was equivalent to 1.2 percent of the total daily CO inventory for 2001.”) As noted above, there is no bright line for assessing contribution, but as discussed in the Proposed Findings and above, when looking at a global problem like climate change, with many sources of emissions and no dominating sources from a global perspective, it is reasonable to consider that lower percentages contribute than one may consider when looking at a local or regional problem involving fewer sources of emissions. The Administrator agrees that “[j]udged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, * * * to global warming.” *Massachusetts v. EPA*, 549 U.S. at 525.

VI. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

Under Executive Order (EO) 12866 (58 FR 51735, October 4, 1993), this action is a “significant regulatory action” because it raises novel policy issues. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under EO 12866 and any changes made in response to Office of Management and Budget (OMB) recommendations have been documented in the docket for this action.

B. Paperwork Reduction Act

This action does not impose an information collection burden under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* Burden is defined at 5 CFR 1320.3(b). These Findings do not impose an information collection request on any person.

C. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small

organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this action on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration’s (SBA) regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

Because these Findings do not impose any requirements, the Administrator certifies that this action will not have a significant economic impact on a substantial number of small entities. This action does not impose any requirements on small entities. The endangerment and cause or contribute findings do not in-and-of-themselves impose any new requirements but rather set forth the Administrator’s determination on whether greenhouse gases in the atmosphere may reasonably be anticipated to endanger public health or welfare, and whether emissions of greenhouse gases from new motor vehicles and engines contribute to this air pollution. Accordingly, the action affords no opportunity for EPA to fashion for small entities less burdensome compliance or reporting requirements or timetables or exemptions from all or part of the Findings.

D. Unfunded Mandates Reform Act

This action contains no Federal mandates under the provisions of Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), 2 U.S.C. 1531–1538 for State, local, or tribal governments or the private sector. The action imposes no enforceable duty on any State, local or tribal governments or the private sector. Therefore, this action is not subject to the requirements of sections 202 or 205 of the UMRA.

This action is also not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. This finding does not impose any requirements on industry or other entities.

E. Executive Order 13132: Federalism

This action does not have federalism implications. Because this action does not impose requirements on any entities, it will not have substantial direct effects on the States, on the relationship between the national

government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. Thus, Executive Order 13132 does not apply to this action.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This action does not have substantial direct effects on one or more Indian tribes, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes, nor does it impose any enforceable duties on any Indian tribes. Thus, Executive Order 13175 does not apply to this action.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

EPA interprets EO 13045 (62 FR 19885, April 23, 1997) as applying only to those regulatory actions that concern health or safety risks, such that the analysis required under section 5–501 of the EO has the potential to influence the regulation. This action is not subject to EO 13045 because it does not establish an environmental standard intended to mitigate health or safety risks. Although the Administrator considered health and safety risks as part of these Findings, the Findings themselves do not impose a standard intended to mitigate those risks.

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

This action is not a “significant energy action” as defined in Executive Order 13211 (66 FR 28355 (May 22, 2001)), because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy because it does not impose any requirements.

I. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (“NTTAA”), Public Law 104–113, 12(d) (15 U.S.C. at 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus

standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This action does not involve technical standards. Therefore, EPA did not consider the use of any voluntary consensus standards.

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order (EO) 12898 (59 FR 7629, Feb. 16, 1994) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent

practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

EPA has determined that these Findings will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it does not affect the level of protection provided to human health or the environment. Although the Administrator considered climate change risks to minority or low-income populations as part of these Findings, this action does not impose a standard intended to mitigate those risks and does not impose requirements on any entities.

K. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 *et seq.*, as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States. This action is not a "major rule" as defined by 5 U.S.C. 804(2). This rule will be effective January 14, 2010.

Dated: December 7, 2009.

Lisa P. Jackson,
Administrator.

[FR Doc. E9-29537 Filed 12-14-09; 8:45 am]
BILLING CODE 6560-50-P

**Endangerment and Cause or
Contribute Findings for
Greenhouse Gases under
Section 202(a) of the
Clean Air Act**

December 7, 2009



Climate Change Division, Office of Atmospheric Programs
U.S. Environmental Protection Agency
Washington, DC

Acknowledgments**EPA authors and contributors:**

Benjamin DeAngelo, Jason Samenow, Jeremy Martinich, Doug Grano, Dina Kruger, Marcus Sarofim, Lesley Jantarasami, William Perkins, Michael Kolian, Melissa Weitz, Leif Hockstad, William Irving, Lisa Hanle, Darrell Winner, David Chalmers, Brian Cook, Chris Weaver, Susan Julius, Brooke Hemming, Sarah Garman, Rona Birnbaum, Paul Argyropoulos, Al McGartland, Alan Carlin, John Davidson, Tim Benner, Carol Holmes, John Hannon, Jim Ketcham-Colwill, Andy Miller, and Pamela Williams.

Federal expert reviewers

Virginia Burkett, USGS; Phil DeCola; NASA (on detail to OSTP); William Emanuel, NASA; Anne Grambsch, EPA; Jerry Hatfield, USDA; Anthony Janetos; DOE Pacific Northwest National Laboratory; Linda Joyce, USDA Forest Service; Thomas Karl, NOAA; Michael McGeehin, CDC; Gavin Schmidt, NASA; Susan Solomon, NOAA; and Thomas Wilbanks, DOE Oak Ridge National Laboratory.

Other contributors:

Eastern Research Group (ERG) assisted with document editing and formatting.

Stratus Consulting also assisted with document editing and formatting.

Table of Contents

Executive Summary	ES-1
I. Introduction	
1. Introduction and Background	2
a. Scope and Approach of This Document.....	2
b. Data and Scientific Findings Considered by EPA.....	4
c. Roadmap for This Document	8
II. Greenhouse Gas Emissions	
2. Greenhouse Gas Emissions and Concentrations	11
a. U.S. and Global Greenhouse Gas and Selected Aerosol Emissions.....	11
b. Lifetime of Greenhouse Gases in the Atmosphere.....	16
c. Historic and Current Global Greenhouse Gas Concentrations	17
III. Global and U.S. Observed and Projected Effects From Elevated Greenhouse Gas Concentrations	
3. Direct Effects of Elevated Greenhouse Gas Concentrations	21
4. Radiative Forcing and Observed Climate Change	23
a. Radiative Forcing Due to Greenhouse Gases and Other Factors	23
b. Global Changes in Temperature.....	26
c. U.S. Changes in Temperature.....	32
d. Global Changes in Precipitation.....	34
e. U.S. Changes in Precipitation.....	35
f. Global Sea Level Rise and Ocean Heat Content	35
g. U.S. Sea Level Rise.....	37
h. Global Ocean Acidification.....	38
i. Global Changes in Physical and Biological Systems.....	38
j. U.S. Changes in Physical and Biological Systems.....	41
k. Global Extreme Events.....	43
l. U.S. Extreme Events	44
5. Attribution of Observed Climate Change to Anthropogenic Greenhouse Gas Emissions at the Global and Continental Scale	47
a. Attribution of Observed Climate Change to Anthropogenic Emissions	47
b. Attribution of Observed Changes in Physical and Biological Systems.....	53
6. Projected Future Greenhouse Gas Concentrations and Climate Change	55
a. Global Emissions Scenarios and Associated Changes in Concentrations and Radiative Forcing	55
b. Projected Changes in Global Temperature, Precipitation Patterns, Sea Level Rise, and Ocean Acidification	63
c. Projected Changes in U.S. Temperature, Precipitation Patterns, and Sea Level Rise.....	68
d. Cryosphere (Snow and Ice) Projections, Focusing on North America and the United States.....	72
e. Extreme Events, Focusing on North America and the United States	73

f. Abrupt Climate Change and High-Impact Events..... 75
 g. Effects on/from Stratospheric Ozone 78
 h. Land Use and Land Cover Change..... 80

IV. U.S. Observed and Projected Human Health and Welfare Effects from Climate Change

7. Human Health..... 82
 a. Temperature Effects 83
 b. Extreme Events..... 85
 c. Climate-Sensitive Diseases 86
 d. Aeroallergens..... 88

8. Air Quality..... 89
 a. Tropospheric Ozone 89
 b. Particulate Matter 93
 c. Health Effects Due to CO₂-Induced Increases in Tropospheric Ozone and Particulate Matter 96

9. Food Production and Agriculture 97
 a. Crop Yields and Productivity 98
 b. Irrigation Requirements..... 100
 c. Climate Variability and Extreme Events 101
 d. Pests and Weeds 101
 e. Livestock 102
 f. Freshwater and Marine Fisheries..... 103

10. Forestry..... 104
 a. Forest Productivity 105
 b. Wildfire and Drought Risk 106
 c. Forest Composition 108
 d. Insects and Diseases 108

11. Water Resources 110
 a. Water Supply and Snowpack 110
 b. Water Quality 113
 c. Extreme Events..... 115
 d. Implications for Water Uses..... 116

12. Sea Level Rise and Coastal Areas..... 117
 a. Vulnerable Areas 117
 b. Extreme Events..... 120

13. Energy, Infrastructure, and Settlements 122
 a. Heating and Cooling Requirements..... 122
 b. Energy Production 123
 c. Infrastructure and Settlements..... 125

14. Ecosystems and Wildlife..... 131
 a. Ecosystems and Species 131
 b. Ecosystem Services 138
 c. Extreme Events..... 139

d. Implications for Tribes	139
e. Implications for Tourism	140
15. U.S. Regional Climate Change Impacts	141
a. Northeast	142
b. Southeast	143
c. Midwest	144
d. Great Plains	146
e. Southwest	148
f. Northwest	150
g. Alaska	152
h. Islands	153
V. Observed and Projected Human Health and Welfare Effects From Climate Change in Other World Regions	
16. Impacts in Other World Regions	157
a. National Security Concerns	157
b. Overview of International Impacts	159
References	164
Appendix A: Brief Overview of Adaptation	176
Appendix B: Greenhouse Gas Emissions From Section 202(a) Source Categories	180
Appendix C: Direct Effects of GHGs on Human Health	195

Executive Summary

This document provides technical support for the endangerment and cause or contribute analyses concerning greenhouse gas (GHG) emissions under section 202(a) of the Clean Air Act. This document itself does not convey any judgment or conclusion regarding the question of whether GHGs may be reasonably anticipated to endanger public health or welfare, as this decision is ultimately left to the judgment of the Administrator. The conclusions here and the information throughout this document are primarily drawn from the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the U.S. Climate Change Science Program (CCSP), the U.S. Global Change Research Program (USGCRP), and the National Research Council (NRC).

Observed Trends in Greenhouse Gas Emissions and Concentrations

Greenhouse gases, once emitted, can remain in the atmosphere for decades to centuries, meaning that 1) their concentrations become well-mixed throughout the global atmosphere regardless of emission origin, and 2) their effects on climate are long lasting. The primary long-lived GHGs directly emitted by human activities include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). Greenhouse gases have a warming effect by trapping heat in the atmosphere that would otherwise escape to space.

In 2007, U.S. GHG emissions were 7,150 teragrams¹ of CO₂ equivalent² (TgCO₂eq). The dominant gas emitted is CO₂, mostly from fossil fuel combustion. Methane is the second largest component of U.S. emissions, followed by N₂O and the fluorinated gases (HFCs, PFCs, and SF₆). Electricity generation is the largest emitting sector (34% of total U.S. GHG emissions), followed by transportation (28%) and industry (19%).

Transportation sources under Section 202 of the Clean Air Act (passenger cars, light duty trucks, other trucks and buses, motorcycles, and cooling) emitted 1,649 TgCO₂eq in 2007, representing 23% of total U.S. GHG emissions.

U.S. transportation sources under Section 202 made up 4.3% of total global GHG emissions in 2005, which, in addition to the United States as a whole, ranked only behind total GHG emissions from China, Russia, and India but ahead of Japan, Brazil, Germany, and the rest of the world's countries. In 2005, total U.S. GHG emissions were responsible for 18% of global emissions, ranking only behind China, which was responsible for 19% of global GHG emissions.

U.S. emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), direct particulates, and ozone precursors have decreased in recent decades, due to regulatory actions and improvements in technology. Sulfur dioxide (SO₂) emissions in 2007 were 5.9 Tg of sulfur, primary fine particulate matter (PM_{2.5}) emissions in 2005 were 5.0 Tg, NO_x emissions in 2005 were 18.5 Tg, volatile organic compound (VOC) emissions in 2005 were 16.8 Tg, and ammonia emissions in 2005 were 3.7 Tg.

The global atmospheric CO₂ concentration has increased about 38% from pre-industrial levels to 2009, and almost all of the increase is due to anthropogenic emissions. The global atmospheric

¹ One teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kilograms = 1.102 short tons = 2,205 pounds.

² Long-lived GHGs are compared and summed together on a CO₂-equivalent basis by multiplying each gas by its global warming potential (GWP), as estimated by IPCC. In accordance with United Nations Framework Convention on Climate Change (UNFCCC) reporting procedures, the U.S. quantifies GHG emissions using the 100-year timeframe values for GWPs established in the IPCC Second Assessment Report.

concentration of CH₄ has increased by 149% since pre-industrial levels (through 2007); and the N₂O concentration has increased by 23% (through 2007). The observed concentration increase in these gases can also be attributed primarily to anthropogenic emissions. The industrial fluorinated gases, HFCs, PFCs, and SF₆, have relatively low atmospheric concentrations but the total radiative forcing due to these gases is increasing rapidly; these gases are almost entirely anthropogenic in origin.

Historic data show that current atmospheric concentrations of the two most important directly emitted, long-lived GHGs (CO₂ and CH₄) are well above the natural range of atmospheric concentrations compared to at least the last 650,000 years. Atmospheric GHG concentrations have been increasing because anthropogenic emissions have been outpacing the rate at which GHGs are removed from the atmosphere by natural processes over timescales of decades to centuries.

Observed Effects Associated With Global Elevated Concentrations of GHGs

Current ambient air concentrations of CO₂ and other GHGs remain well below published exposure thresholds for any direct adverse health effects, such as respiratory or toxic effects.

The global average net effect of the increase in atmospheric GHG concentrations, plus other human activities (e.g., land-use change and aerosol emissions), on the global energy balance since 1750 has been one of warming. This total net heating effect, referred to as forcing, is estimated to be +1.6 (+0.6 to +2.4) watts per square meter (W/m²), with much of the range surrounding this estimate due to uncertainties about the cooling and warming effects of aerosols. However, as aerosol forcing has more regional variability than the well-mixed, long-lived GHGs, the global average might not capture some regional effects. The combined radiative forcing due to the cumulative (i.e., 1750 to 2005) increase in atmospheric concentrations of CO₂, CH₄, and N₂O is estimated to be +2.30 (+2.07 to +2.53) W/m². The rate of increase in positive radiative forcing due to these three GHGs during the industrial era is very likely to have been unprecedented in more than 10,000 years.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Global mean surface temperatures have risen by 1.3 ± 0.32°F (0.74°C ± 0.18°C) over the last 100 years. Eight of the 10 warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.

Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. Climate model simulations suggest natural forcing alone (i.e., changes in solar irradiance) cannot explain the observed warming.

U.S. temperatures also warmed during the 20th and into the 21st century; temperatures are now approximately 1.3°F (0.7°C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC and the CCSP reports attributed recent North American warming to elevated GHG concentrations. In the CCSP (2008g) report, the authors find that for North America, “more than half of this warming [for the period 1951-2006] is likely the result of human-caused greenhouse gas forcing of climate change.”

Observations show that changes are occurring in the amount, intensity, frequency and type of precipitation. Over the contiguous United States, total annual precipitation increased by 6.1% from 1901 to 2008. It is likely that there have been increases in the number of heavy precipitation events within

many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate.

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate. It is not clear whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend. Nearly all of the Atlantic Ocean shows sea level rise during the last 50 years with the rate of rise reaching a maximum (over 2 millimeters [mm] per year) in a band along the U.S. east coast running east-northeast.

Satellite data since 1979 show that annual average Arctic sea ice extent has shrunk by 4.1% per decade. The size and speed of recent Arctic summer sea ice loss is highly anomalous relative to the previous few thousands of years.

Widespread changes in extreme temperatures have been observed in the last 50 years across all world regions, including the United States. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. However, directly attributing specific regional changes in climate to emissions of GHGs from human activities is difficult, especially for precipitation.

Ocean CO₂ uptake has lowered the average ocean pH (increased acidity) level by approximately 0.1 since 1750. Consequences for marine ecosystems can include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments.

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. The consistency of these observed changes in physical and biological systems and the observed significant warming likely cannot be explained entirely due to natural variability or other confounding non-climate factors.

Projections of Future Climate Change With Continued Increases in Elevated GHG Concentrations

Most future scenarios that assume no explicit GHG mitigation actions (beyond those already enacted) project increasing global GHG emissions over the century, with climbing GHG concentrations. Carbon dioxide is expected to remain the dominant anthropogenic GHG over the course of the 21st century. The radiative forcing associated with the non-CO₂ GHGs is still significant and increasing over time.

Future warming over the course of the 21st century, even under scenarios of low-emission growth, is very likely to be greater than observed warming over the past century. According to climate model simulations summarized by the IPCC, through about 2030, the global warming rate is affected little by the choice of different future emissions scenarios. By the end of the 21st century, projected average global warming (compared to average temperature around 1990) varies significantly depending on the emission scenario and climate sensitivity assumptions, ranging from 3.2 to 7.2°F (1.8 to 4.0°C), with an uncertainty range of 2.0 to 11.5°F (1.1 to 6.4°C).

All of the United States is very likely to warm during this century, and most areas of the United States are expected to warm by more than the global average. The largest warming is projected to occur in winter over northern parts of Alaska. In western, central and eastern regions of North America,

the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans.

It is very likely that heat waves will become more intense, more frequent, and longer lasting in a future warm climate, whereas cold episodes are projected to decrease significantly.

Increases in the amount of precipitation are very likely in higher latitudes, while decreases are likely in most subtropical latitudes and the southwestern United States, continuing observed patterns. The mid-continental area is expected to experience drying during summer, indicating a greater risk of drought.

Intensity of precipitation events is projected to increase in the United States and other regions of the world. More intense precipitation is expected to increase the risk of flooding and result in greater runoff and erosion that has the potential for adverse water quality effects.

It is likely that hurricanes will become more intense, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. Frequency changes in hurricanes are currently too uncertain for confident projections.

By the end of the century, global average sea level is projected by IPCC to rise between 7.1 and 23 inches (18 and 59 centimeter [cm]), relative to around 1990, in the absence of increased dynamic ice sheet loss. Recent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning. While an understanding of these ice sheet processes is incomplete, their inclusion in models would likely lead to increased sea level projections for the end of the 21st century.

Sea ice extent is projected to shrink in the Arctic under all IPCC emissions scenarios.

Projected Risks and Impacts Associated With Future Climate Change

Risk to society, ecosystems, and many natural Earth processes increase with increases in both the rate and magnitude of climate change. Climate warming may increase the possibility of large, abrupt regional or global climatic events (e.g., disintegration of the Greenland Ice Sheet or collapse of the West Antarctic Ice Sheet). The partial deglaciation of Greenland (and possibly West Antarctica) could be triggered by a sustained temperature increase of 2 to 7°F (1 to 4°C) above 1990 levels. Such warming would cause a 13 to 20 feet (4 to 6 meter) rise in sea level, which would occur over a time period of centuries to millennia.

CCSP reports that climate change has the potential to accentuate the disparities already evident in the American health care system, as many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured. IPCC states with very high confidence that climate change impacts on human health in U.S. cities will be compounded by population growth and an aging population.

Severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur, with potential increases in mortality and morbidity, especially among the elderly, young, and frail.

Some reduction in the risk of death related to extreme cold is expected. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality in the United States due to climate change.

Increases in regional ozone pollution relative to ozone levels without climate change are expected due to higher temperatures and weaker circulation in the United States and other world cities relative to air quality levels without climate change. Climate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death. In addition to human health effects, tropospheric ozone has significant adverse effects on crop yields, pasture and forest growth, and species composition. The directional effect of climate change on ambient particulate matter levels remains uncertain.

Within settlements experiencing climate change, certain parts of the population may be especially vulnerable; these include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. Thus, the potential impacts of climate change raise environmental justice issues.

CCSP concludes that, with increased CO₂ and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable. Furthermore, the marketable yield of many horticultural crops (e.g., tomatoes, onions, fruits) is very likely to be more sensitive to climate change than grain and oilseed crops.

Higher temperatures will very likely reduce livestock production during the summer season in some areas, but these losses will very likely be partially offset by warmer temperatures during the winter season.

Cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges.

Climate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska, and will continue to do so. Over North America, forest growth and productivity have been observed to increase since the middle of the 20th century, in part due to observed climate change. Rising CO₂ will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils. The combined effects of expected increased temperature, CO₂, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear.

Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Sea level is rising along much of the U.S. coast, and the rate of change will very likely increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, other coastal habitats, and dependent species are threatened by sea level rise, fixed structures blocking landward migration, and changes in vegetation. Population growth and rising value of infrastructure in coastal areas increases vulnerability to climate variability and future climate change.

Climate change will likely further constrain already overallocated water resources in some regions of the United States, increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations. Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal

availability of water. In the Great Lakes and major river systems, lower water levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and binational relationships. Decreased water supply and lower water levels are likely to exacerbate challenges relating to aquatic navigation in the United States.

Higher water temperatures, increased precipitation intensity, and longer periods of low flows will exacerbate many forms of water pollution, potentially making attainment of water quality goals more difficult. As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to warmer water. In the long term, warmer water and changing flow may result in deterioration of aquatic ecosystems.

Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals.

Climate change is likely to affect U.S. energy use and energy production and physical and institutional infrastructures. It will also likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts. The U.S. energy sector, which relies heavily on water for hydropower and cooling capacity, may be adversely impacted by changes to water supply and quality in reservoirs and other water bodies. Water infrastructure, including drinking water and wastewater treatment plants, and sewer and stormwater management systems, will be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair performance.

Disturbances such as wildfires and insect outbreaks are increasing in the United States and are likely to intensify in a warmer future with warmer winters, drier soils, and longer growing seasons. Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services.

Over the 21st century, changes in climate will cause species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

Climate change impacts will vary in nature and magnitude across different regions of the United States.

- Sustained high summer temperatures, heat waves, and declining air quality are projected in the **Northeast³, Southeast⁴, Southwest⁵, and Midwest⁶**. Projected climate change would continue to cause loss of sea ice, glacier retreat, permafrost thawing, and coastal erosion in **Alaska**.
- Reduced snowpack, earlier spring snowmelt, and increased likelihood of seasonal summer droughts are projected in the **Northeast, Northwest⁷, and Alaska**. More severe, sustained droughts and water scarcity are projected in the **Southeast, Great Plains⁸, and Southwest**.

³ Northeast includes West Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.

⁴ Southeast includes Kentucky, Virginia, Arkansas, Tennessee, North Carolina, South Carolina, southeast Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida.

⁵ Southwest includes California, Nevada, Utah, western Colorado, Arizona, New Mexico (except the extreme eastern section), and southwest Texas.

⁶ The Midwest includes Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri.

⁷ The Northwest includes Washington, Idaho, western Montana, and Oregon.

- The **Southeast, Midwest, and Northwest** in particular are expected to be impacted by an increased frequency of heavy downpours and greater flood risk.
- Ecosystems of the **Southeast, Midwest, Great Plains, Southwest, Northwest, and Alaska** are expected to experience altered distribution of native species (including local extinctions), more frequent and intense wildfires, and an increase in insect pest outbreaks and invasive species.
- Sea level rise is expected to increase storm surge height and strength, flooding, erosion, and wetland loss along the coasts, particularly in the **Northeast, Southeast, and islands**.
- Warmer water temperatures and ocean acidification are expected to degrade important aquatic resources of **islands** and coasts such as coral reefs and fisheries.
- A longer growing season, low levels of warming, and fertilization effects of carbon dioxide may benefit certain crop species and forests, particularly in the **Northeast and Alaska**. Projected summer rainfall increases in the Pacific **islands** may augment limited freshwater supplies. Cold-related mortality is projected to decrease, especially in the **Southeast**. In the **Midwest** in particular, heating oil demand and snow-related traffic accidents are expected to decrease.

Climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade, and national security issues for the United States. The IPCC identifies the most vulnerable world regions as the Arctic, because of the effects of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea level rise and increased storm surge; and Asian mega-deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge and river flooding. Climate change has been described as a potential threat multiplier with regard to national security issues.

⁸ The Great Plains includes central and eastern Montana, North Dakota, South Dakota, Wyoming, Nebraska, eastern Colorado, Nebraska, Kansas, extreme eastern New Mexico, central Texas, and Oklahoma

Part I
Introduction

Section 1

Introduction and Background

The purpose of this Technical Support Document (TSD) is to provide scientific and technical information for an endangerment and cause or contribute analysis regarding greenhouse gas (GHG) emissions from new motor vehicles and engines under Section 202(a) of the Clean Air Act. Section 202 (a)(1) of the Clean Air Act states that:

the Administrator shall by regulation prescribe (and from time to time revise)...standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

Thus before EPA may issue standards addressing emissions of an air pollutant from new motor vehicles or new motor vehicle engines under Section 202(a), the Administrator must make a so-called "endangerment finding." That finding is a two-step test. First, the Administrator must decide if, in her judgment, air pollution may reasonably be anticipated to endanger public health or welfare. Second, the Administrator must decide whether, in her judgment, emissions of any air pollutant from new motor vehicles or engines cause or contribute to this air pollution. If the Administrator answers both questions in the affirmative, EPA shall issue standards under Section 202(a).

This document itself does not convey any judgment or conclusion regarding the two steps of the endangerment finding, as these decisions are ultimately left to the judgment of the Administrator. Readers should refer to the Final Endangerment and Cause or Contribute Findings for Greenhouse Gases (signed December 7, 2009) for a discussion of how the Administrator considered the information contained in this TSD in her determinations regarding the endangerment and cause or contribute findings.

This TSD has been revised and updated since the version of this document released April 17, 2009, to accompany the Administrator's proposed endangerment and cause or contribute findings (74 FR 18886, EPA-HQ-OAR-2009-0171). The proposed findings and TSD were subject to a 60-day public comment period as well as two public hearings. An earlier version of the TSD was released July 11, 2008, to accompany the Advance Notice of Proposed Rulemaking on the Regulation of Greenhouse Gases under the Clean Air Act (73 FR 44353, EPA-HQ-OAR-2008-0318), which was subject to a 120-day public comment period. The draft released in April 2009 has been revised to reflect the most up-to-date GHG emissions and climate data, a new major scientific assessment by the U.S. Global Change Research Program (USGCRP), and EPA's responses to significant public comments pertaining to the draft TSD.⁹ The remainder of this introductory chapter explains the scope and approach of this document and the underlying references and data sources on which it relies.

1(a) Scope and Approach of This Document

The primary GHGs that are directly emitted by human activities in general are those reported in EPA's annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* and include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF₆). The primary effect of these gases is their influence on the climate system by trapping

⁹ Detailed responses to all significant public comments received on the Administrator's Proposed Endangerment and Cause or Contribute Findings released on April 17, 2009, can be found in the separate Response to Comments document.

heat in the atmosphere that would otherwise escape to space. This heating effect (referred to as radiative forcing) is very likely to be the cause of most of the observed global warming over the last 50 years. Global warming and climate change can, in turn, affect health, society, and the environment. There also are some cases where these gases have other non-climate effects. For example, elevated concentrations of CO₂ can lead to ocean acidification and stimulate terrestrial plant growth, and CH₄ emissions can contribute to background levels of tropospheric ozone, a criteria pollutant. These effects can in turn be influenced by climate change in certain cases. Carbon dioxide and other GHGs can also have direct health effects but at concentrations far in excess of current or projected future ambient concentrations. There are other known anthropogenic forcing agents that influence climate, such as changes in land use, which can in turn change surface reflectivity, as well as emissions of aerosols, which can have both heating and cooling influences on the climate. These other forcing agents are discussed as well to place the anthropogenic GHG influence in context.

This document reviews a wide range of observed and projected vulnerabilities, risks, and impacts due to the elevated levels of GHGs in the atmosphere and associated climate change. Any known or expected benefits of elevated atmospheric concentrations of GHGs or of climate change are documented as well (recognizing that climate impacts can have both positive and negative consequences). The extent to which observed climate change can be attributed to anthropogenic GHG emissions is assessed. The term "climate change" in this document generally refers to climate change induced by human activities, including activities that emit GHGs. Future projections of climate change, based primarily on future scenarios of anthropogenic GHG emissions, are shown for the global and national scale.

The vulnerability, risk, and impact assessment in this document primarily focuses on the United States. However, given the global nature of climate change, there is a brief review of potential impacts in other regions of the world. Greenhouse gases, once emitted, become well mixed in the atmosphere, meaning U.S. emissions can affect not only the U.S. population and environment but other regions of the world as well; likewise, emissions in other countries can affect the United States. Furthermore, impacts in other regions of the world may have consequences that in turn raise humanitarian, trade, and national security concerns for the United States.

The timeframe over which vulnerabilities, risks, and impacts are considered is consistent with the timeframe over which GHGs, once emitted, have an effect on climate, which is decades to centuries for the primary GHGs of concern. Therefore, in addition to reviewing recent observations, this document generally considers the next several decades, until approximately 2100, and for certain impacts, beyond 2100.

Adaptation to climate change is a key focus area of the climate change research community. This document, however, does not assess the climate change impacts in light of potential adaptation measures. This is because adaptation is essentially a response to any known and/or perceived risks due to climate change. Likewise, mitigation measures to reduce GHGs, which could also reduce long-term risks, are not explicitly addressed. The purpose of this document is to review the effects of climate change and not to assess any potential policy or societal response to climate change. There are cases in this document, however, where some degree of adaptation is accounted for; these cases occur where the literature on which this document relies already incorporates information about adaptation that has already occurred or uses assumptions about adaptation when projecting the future effects of climate change. Such cases are noted in the document.¹⁰

¹⁰ A brief overview of adaptation is provided in Appendix A.

I(b) Data and Scientific Findings Considered by EPA

This document relies most heavily on existing, and in most cases very recent, synthesis reports of climate change science and potential impacts, which have undergone their own peer-review processes, including review by the U.S. government. Box 1.1 describes this process¹¹. The information in this document has been developed and prepared in a manner that is consistent with EPA's *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by the Environmental Protection Agency* (U.S. EPA 2002). In addition to its reliance on existing and recent synthesis reports, which have each gone through extensive peer-review procedures, this document also underwent a technical review by 12 federal climate change experts, internal EPA review, interagency review, and a public comment period.

Box 1.1: Peer Review, Publication, and Approval Processes for IPCC, CCSP/USGCRP, and NRC Reports**Intergovernmental Panel on Climate Change**

The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It bases its assessment mainly on peer reviewed and published scientific/technical literature. IPCC has established rules and procedures for producing its assessment reports. Report outlines are agreed to by government representatives in consultation with the IPCC bureau. Lead authors are nominated by governments and are selected by the respective IPCC Working Groups on the basis of their scientific credentials and with due consideration for broad geographic representation. For Working Group I (The Physical Science Basis) there were 152 coordinating lead authors, and for Working Group II (Impacts, Adaptation and Vulnerability) there were 48 coordinating lead authors. Drafts prepared by the authors are subject to two rounds of review; the first round is technical (or "expert" in the IPCC lexicon), and the second round includes government review. For the IPCC Working Group I report, more than 30,000 written comments were submitted by over 650 individual experts, governments, and international organizations. For Working Group II there were 910 expert reviewers. Under the IPCC procedures, review editors for each chapter are responsible for ensuring that all substantive government and expert review comments receive appropriate consideration. For transparency, IPCC documents how every comment is addressed. Each Summary for Policymakers is approved line-by-line, and the underlying chapters then accepted, by government delegations in formal plenary sessions. Further information about IPCC's (2009) principles and procedures can be found at: http://www.ipcc.ch/organization/organization_procedures.htm.

U.S. Climate Change Science Program and U.S. Global Change Research Program

Under the Bush Administration, the U.S. Climate Change Science Program (CCSP) integrated federal research on climate and global change, as sponsored by thirteen federal agencies and overseen by the Office of Science and Technology Policy, the Council on Environmental Quality, the National Economic Council and the Office of Management and Budget. As of January 16, 2009, the CCSP had completed 21 synthesis and assessment products (SAPs) that address the highest priorities for U.S. climate change research, observation, and decision support needs. Different agencies were designated the lead for different SAPs; EPA was the designated lead for three of the six SAPs addressing impacts and adaptation. For each SAP, there was first a prospectus that provided an outline, the proposed authors, and the process for completing the SAP; this went through two stages of expert, interagency, and public review. Authors produced a first draft that went through expert review; a second draft was posted for public review. The designated lead agency ensured that the third draft complied with the Information Quality Act. Finally, each SAP was submitted for approval by the National Science and Technology Council (NSTC), a cabinet-level council that coordinates science and technology research across the federal government. Further information about the clearance and review procedures for the CCSP SAPs can be found at: <http://www.climatechange.gov/Library/sap/sap-guidelines-clarification-aug2007.htm>.

In June 2009, the U.S. Global Change Research Program (which had been incorporated under the CCSP during the

¹¹ Volume 1 of EPA's Response to Comments document on the on the Administrator's Endangerment and Cause or Contribute Findings, provides more detailed information on these review processes.

Bush Administration, but, as of January 2009, was re-established as the comprehensive and integrating body for global change research, subsuming CCSP and its products) completed an assessment, *Global Climate Change Impacts in the United States* that incorporated all 21 SAPs from the CCSP, as well as the IPCC Fourth Assessment Report. As stated in that report, "This report meets all Federal requirements associated with the Information Quality Act, including those pertaining to public comment and transparency."

National Research Council of the U.S. National Academy of Sciences

The National Research Council (NRC) is part of the National Academies, which also comprise the National Academy of Sciences, National Academy of Engineering and Institute of Medicine. They are private, nonprofit institutions that provide science, technology, and health policy advice under a congressional charter. The NRC has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. Federal agencies are the primary financial sponsors of the Academies' work. The Academies provide independent advice; the external sponsors have no control over the conduct of a study once the statement of task and budget are finalized. The NRC (2001a) study, *Climate Change Science: An Analysis of Some Key Questions*, originated from a White House request. The NRC (2001b) study, *Global Air Quality: An Imperative for Long-Term Observational Strategies*, was supported by EPA and NASA. The NRC 2004 study, *Air Quality Management in the United States*, was supported by EPA. The NRC 2005 study, *Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties*, was in response to a CCSP request and was supported by NOAA. The NRC (2006b) study, *Surface Temperature Reconstructions for the Last 2,000 Years*, was requested by the Science Committee of the U.S. House of Representatives. Each NRC report is authored by its own committee of experts, reviewed by outside experts, and approved by the Governing Board of the NRC.

Table 1.1 lists the core reference documents for this TSD. These include the *2007 Fourth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC), the *Synthesis and Assessment Products of the U.S. Climate Change Science Program* (CCSP) published between 2006 and 2009, the 2009 USGCRP scientific assessment, National Research Council (NRC) reports under the U.S. National Academy of Sciences (NAS), the National Oceanic and Atmospheric Administration's (NOAA's) 2009 *State of the Climate in 2008* report, the 2009 EPA annual *U.S. Inventory of Greenhouse Gas Emissions and Sinks*, and the 2009 EPA assessment of the impacts of global change on regional U.S. air quality.

This version of the TSD, as well as previous versions of the TSD dating back to 2007, have taken the approach of relying primarily on these assessment reports because they 1) are very recent and represent the current state of knowledge on GHG emissions, climate change science, vulnerabilities, and potential impacts; 2) have assessed numerous individual, peer-reviewed studies in order to draw general conclusions about the state of science; 3) have been reviewed and formally accepted, commissioned, or in some cases authored by U.S. government agencies and individual government scientists; and 4) they reflect and convey the consensus conclusions of expert authors. Box 1.1 describes the peer review and publication approval processes of IPCC, CCSP/USGCRP and NRC reports. Peer review and transparency are central to each of these research organizations' report development process. Given the comprehensiveness of these assessments and their review processes, these assessment reports provide EPA with assurances that this material has been well vetted by both the climate change research community and by the U.S. government. Furthermore, use of these assessments complies with EPA's information quality guidelines, as this document relies on information that is objective, technically sound and vetted, and of high integrity.¹²

¹² The Response to Comments document, which also accompanies the Administrator's final Endangerment and Cause or Contribute Findings, contains additional information about EPA's responses to comments received about EPA's use of assessment reports such as those from IPCC and USGCRP, as well as issues concerning the Data Quality Act.

Table 1.1 Core references relied upon most heavily in this document.

Science Body/Author	Short Title and Year of Publication
NOAA	State of the Climate in 2008 (2009)
USGCRP	Global Climate Change Impacts in the United States (2009)
IPCC	Working Group I: The Physical Science Basis (2007)
IPCC	Working Group II: Impacts, Adaptation and Vulnerability (2007)
IPCC	Working Group III: Mitigation of Climate Change (2007)
CCSP	SAP 1.1: Temperature Trends in the Lower Atmosphere (2006)
CCSP	SAP 1.2: Past Climate Variability and Change in the Arctic and at High Latitudes (2009)
CCSP	SAP 1.3: Re-analyses of Historical Climate Data (2008)
CCSP	SAP 2.1: Scenarios of GHG Emissions and Atmospheric Concentrations (2007)
CCSP	SAP 2.3: Aerosol Properties and their Impacts on Climate
CCSP	SAP 2.4: Trends in Ozone-Depleting Substances (2008)
CCSP	SAP 3.1: Climate Change Models (2008)
CCSP	SAP 3.2: Climate Projections (2008)
CCSP	SAP 3.3: Weather and Climate Extremes in a Changing Climate (2008)
CCSP	SAP 3.4: Abrupt Climate Change (2008)
CCSP	SAP 4.1: Coastal Sensitivity to Sea Level Rise (2009)
CCSP	SAP 4.2: Thresholds of Change in Ecosystems (2009)
CCSP	SAP 4.3: Agriculture, Land Resources, Water Resources, and Biodiversity (2008)
CCSP	SAP 4.5: Effects on Energy Production and Use (2007)
CCSP	SAP 4.6: Analyses of the Effects of Global Change on Human Health (2008)
CCSP	SAP 4.7: Impacts of Climate Change and Variability on Transportation Systems (2008)
NRC	Climate Change Science: Analysis of Some Key Questions (2001)
NRC	Radiative Forcing of Climate Change (2005)
NRC	Surface Temperature Reconstructions for the Last 2,000 Years (2006)
NRC	Potential Impacts of Climate Change on U.S. Transportation (2008)
EPA	Impacts of Global Change on Regional U.S. Air Quality (2009)
EPA	Inventory of U.S. Greenhouse Gas Emissions and Sinks (2009)
ACIA	Arctic Climate Impact Assessment (2004)

Uncertainties and confidence levels associated with the scientific conclusions and findings in this document are reported, to the extent that such information was provided in the original scientific reports upon which this document is based. Box 1.2 describes the lexicon used by IPCC to communicate uncertainty and confidence levels associated with the most important IPCC findings. The CCSP and USGCRP generally adopted the same lexicon with their respective definitions. Therefore, this document employs the same lexicon when referencing IPCC, CCSP and USGCRP statements.

Box 1.2: Communication of Uncertainty in the IPCC Fourth Assessment Report and CCSP/USGCRP

Because some aspects of climate change are better understood, established, and/or resolved than others and involve projections, it is helpful to precisely convey the degree of certainty of statements and findings. Uncertainty can arise from a variety of sources: (1) a misspecification of the cause(s), such as the omissions of a causal factor resulting in spurious correlations; (2) mischaracterization of effect(s), such as a model that predicts cooling rather than warming; (3) absence of or imprecise measurement or calibration; (4) fundamental stochastic (chance) processes; (5) ambiguity over the temporal ordering of cause and effect; (6) time delays in cause and effect; and (7) complexity where cause and effect between certain factors are camouflaged by a context with multiple causes and effects, feedback loops, and considerable noise (CCSP, 2008b). For this reason, climate change assessments have developed procedures and terminology for communicating uncertainty. Consistent and transparent treatment of uncertainty helps minimize ambiguity and opportunities for misinterpretation of language.

IPCC Fourth Assessment Report Uncertainty Treatment

A set of terms to describe uncertainties in current knowledge is common to all parts of the IPCC *Fourth Assessment Report* based on the *Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties* (<http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-uncertaintyguidancenote.pdf>), produced by the IPCC in July 2005 (IPCC, 2005). Any use of these terms in association with IPCC statements in this Technical Support Document carries the same meaning as originally intended in the IPCC *Fourth Assessment Report*.

Description of confidence

Based on a comprehensive reading of the literature and their expert judgment, authors have assigned a confidence level as to the correctness of a model, an analysis, or a statement as follows:

Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than a 1 out of 10 chance

Description of likelihood

Likelihood refers to a probabilistic assessment of some well defined outcome having occurred or occurring in the future, and may be based on quantitative analysis or an elicitation of expert views. When authors evaluate the likelihood of certain outcomes, the associated meanings are:

Virtually certain	>99% probability of occurrence
Very likely	90 to 99% probability
Likely	66 to 90% probability
About as likely as not	33 to 66% probability
Unlikely	10 to 33% probability
Very unlikely	1 to 10% probability
Exceptionally unlikely	<1% probability

CCSP/USGCRP Uncertainty Treatment

In many of its SAPs and its report "Global Climate Change Impacts in the United States" (Karl et al., 2009), the CCSP/USGCRP uses the same or similar terminology to the IPCC to describe confidence and likelihood. However, there is some variability from report to report, so readers should refer to the individual SAPs for a full accounting of the respective uncertainty language. In this document, when referencing CCSP/USGCRP reports, EPA attempted to reflect the underlying CCSP/USGCRP reports' terminology for communicating uncertainty.

Throughout this document, when these various assessments are referred to in general or as a whole, the full reports are cited. For example, a general reference to the CCSP report *Weather and Climate Extremes in a Changing Climate* is cited as “CCSP, 2008i” (the “i” differentiates the report from other CCSP reports published that same year). When specific findings or conclusions from these larger assessment reports are referenced, citations are given for the relevant individual chapter or section. For example, a finding from CCSP, 2008i, Chapter 5 “Observed Changes in Weather and Climate” by Kunkel et al., is cited as “Kunkel et al., 2008.” In some cases, this document references other reports and studies in addition to the core references of IPCC, CCSP/USGCRP, NRC, and, for GHG emissions, EPA. These references are primarily for major reports and studies produced by U.S. federal and state government agencies. This document also references data made available by other government agencies, such as NOAA and National Aeronautics and Space Administration (NASA).

EPA recently completed and published an assessment of the literature on the effect of climate change on air quality (U.S. EPA, 2009a). Therefore, because EPA evaluated the literature in the preparation of that assessment, EPA does cite some individual studies it reviewed in its summary of this topic in Section 8. Also, for Section 16a on the national security implications of climate change, this document cites a number of analyses and publications, from inside and outside the government, because IPCC and CCSP/USGCRP assessments have not traditionally addressed these issues.

EPA recognizes that scientific research is very active and constantly evolving in many areas addressed in this document (e.g., aerosol effects on climate, climate feedbacks such as water vapor, and internal and external climate forcing mechanisms) as well as for some emerging issues (e.g., ocean acidification, and climate change effects on water quality). For this very reason, major assessments are conducted periodically by the scientific community to update the general understanding of the effects of GHG emissions on the climate and on the numerous impact sectors; such a process places individual, less-comprehensive studies in the context of the broader body of peer-reviewed literature.

EPA reviewed new literature in preparation of this TSD to evaluate its consistency with recent scientific assessments. We also considered public comments received and studies incorporated by reference. In a number of cases, the TSD was updated based on such information to add context for assessment literature findings which includes supporting information and/or qualifying statements. In other cases, material that was not incorporated into the TSD is discussed within the Response to Comments document¹³ as part of EPA’s responses to key scientific and technical comments received by the public.

1(c) Roadmap for This Document

The remainder of this document is structured as follows:

- **Part II, Section 2** describes sources of U.S. and global GHG emissions. How anthropogenic GHG emissions have contributed to changes in global atmospheric concentrations of GHGs is described, along with other anthropogenic drivers of climate change.

¹³ The Response to Comments document addresses many individual studies that were either included or referenced as part of the public comments. These individual studies may not be reflected in this TSD if the studies were not or have not yet been incorporated into the major and more comprehensive assessments on which this TSD relies. EPA considered all studies submitted to the Agency through the public comment process. Refer to sections I.C.3 and III.A in Final Endangerment and Cause or Contribute Findings for Greenhouse Gases for further discussion on the scientific information from which the findings are based.

- **Part III, Sections 3 – 6** describe the effects of elevated GHG concentrations including any direct health and environmental effects (3); the heating or radiative forcing effects on the climate system (4); observed climate change (e.g., changes in temperature, precipitation and sea level rise) for the United States and for the globe (5); and recent conclusions about the extent to which observed climate change can be attributed to the elevated levels of GHG concentrations; these sections also summarize future projections of climate change—driven primarily by scenarios of anthropogenic GHG emissions—for the remainder of this century (6).
- **Part IV, Sections 7 – 15** review recent findings for the broad range of observed and projected vulnerabilities, risks, and impacts for human health, society, and the environment within the United States due to climate change. The specific sectors, systems and regions include:
 - Human health (7)
 - Air Quality (8)
 - Food Production and Agriculture (9)
 - Forestry (10)
 - Water Resources (11)
 - Coastal Areas (12)
 - Energy, Infrastructure and Settlements (13)
 - Ecosystems and Wildlife (14)
 - Regional Risks and Impacts for the United States (15)
- **Part V, Section 16** briefly addresses some key impacts in other world regions that may occur due to climate change, with a view towards how some of these impacts may in turn affect the United States.
 - **Impacts in Other World Regions** (16)

Part II
Greenhouse Gas Emissions and Concentrations

Section 2

Greenhouse Gas Emissions and Concentrations

This section first describes current U.S. and global anthropogenic GHG emissions, as well as historic and current global GHG atmospheric concentrations. Future GHG emissions scenarios are described in Part III, Section 6; however, these scenarios primarily focus on global emissions, rather than detailing individual U.S. sources.

2(a) U.S. and Global Greenhouse Gas and Selected Aerosol Emissions

To track the national trend in GHG emissions and carbon removals since 1990, EPA develops the official U.S. GHG inventory each year. In accordance with Article 4.1 of the United Nations Framework Convention on Climate Change (UNFCCC), the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* includes emissions and removals of carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆) resulting from anthropogenic activities in the United States.

Total emissions are presented in teragrams¹⁴ (Tg) of CO₂ equivalent (TgCO₂eq), consistent with IPCC inventory guidelines. To determine the CO₂ equivalency of different GHGs, in order to sum and compare different GHGs, emissions of each gas are multiplied by its global warming potential (GWP), a factor that relates it to CO₂ in its ability to trap heat in the atmosphere over a certain timeframe. Box 2.1 provides more information about GWPs and the GWP values used throughout this report.

Box 2.1: Global Warming Potentials Used in This Document

In accordance with UNFCCC reporting procedures, the United States quantifies GHG emissions using the 100-year timeframe values for GWPs established in the IPCC Second Assessment Report (SAR) (IPCC, 1996). The GWP index is defined as the cumulative radiative forcing between the present and some chosen later time horizon (100 years) caused by a unit mass of gas emitted now. All GWPs are expressed relative to a reference gas, CO₂, which is assigned a GWP = 1. Estimation of the GWPs requires knowledge of the fate of the emitted gas and the radiative forcing due to the amount remaining in the atmosphere. To estimate the CO₂ equivalency of a non-CO₂ GHG, the appropriate GWP of that gas is multiplied by the amount of the gas emitted.

100-year GWPs	
CO ₂	1
CH ₄	21
N ₂ O	310
HFCs	140 to 6,300 (depending on type of HFC)
PFCs	6,500 to 9,200 (depending on type of PFC)
SF ₆	23,900

The GWP for CH₄ includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapor. These GWP values have been updated twice in the IPCC Third (IPCC, 2001c) and Fourth Assessment Reports (IPCC, 2007a).

The national inventory totals used in this report for the United States (and other countries) are gross emissions, which include GHG emissions from the electricity, industrial, commercial, residential, and agriculture sectors. Emissions and sequestration occurring in the land use, land-use change, and forestry

¹⁴ 1 teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kilograms = 1.102 short tons = 2,205 pounds.

sector (e.g., forests, soil carbon) are not included in gross national totals but are reported under net emission totals (sources and sinks), according to international practice. In the United States, this sector is a significant net sink, while in some developing countries it is a significant net source of emissions.

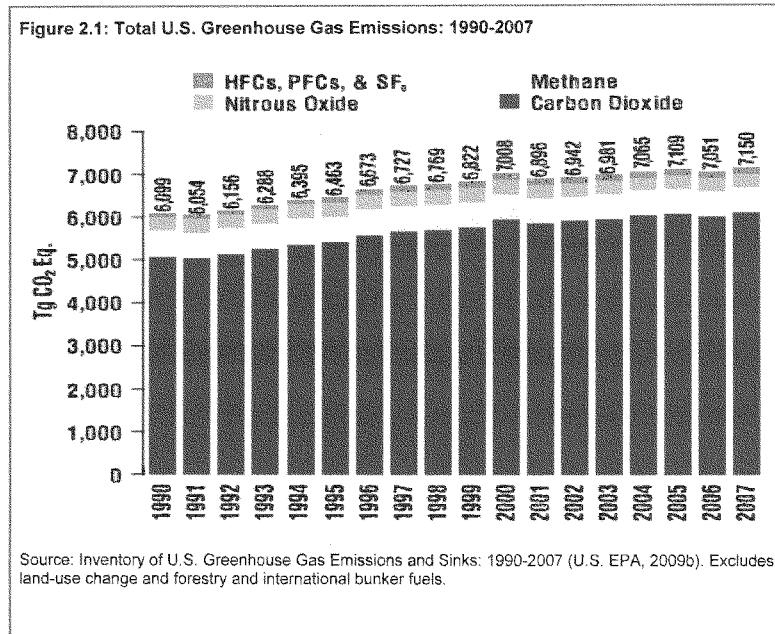
Also excluded from emission totals in this report are bunker fuels (fuels used for international transport). According to UNFCCC reporting guidelines, emissions from the consumption of these fuels should be reported separately and not included in national emission totals, because there exists no agreed upon international formula for allocation between countries.

The most recent inventory was published in 2009 and includes U.S. annual data for the years 1990 to 2007.

U.S. Greenhouse Gas Emissions

In 2007, U.S. GHG emissions were 7,150.1 TgCO₂eq (see Figure 2.1).¹⁵ The dominant gas emitted is CO₂, mostly from fossil fuel combustion (85.4%) (U.S. EPA, 2009b). Weighted by GWP, CH₄ is the second largest component of emissions, followed by N₂O, and the high-GWP fluorinated gases (HFCs, PFCs, and SF₆). Electricity generation (2445.1 TgCO₂eq) is the largest emitting sector, followed by transportation (1995.2 TgCO₂eq) and industry (1386.3 TgCO₂eq) (U.S. EPA, 2009b) (Figure 2.2). Agriculture and the commercial and residential sectors emit 502.8 TgCO₂eq, 407.6 TgCO₂eq, and 355.3 TgCO₂eq, respectively (U.S. EPA, 2009b). Removals of carbon through land use, land-use change and forestry activities are not included in Figure 2.2 but are significant; net sequestration is estimated to be 1062.6 TgCO₂eq in 2007, offsetting 14.9% of total emissions (U.S. EPA, 2009b).

¹⁵ Per UNFCCC reporting requirements, the United States reports its annual emissions in gigagrams (Gg) with two significant digits (http://unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php). For ease of communicating the findings, the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* report presents total emissions in Tg with one significant digit.



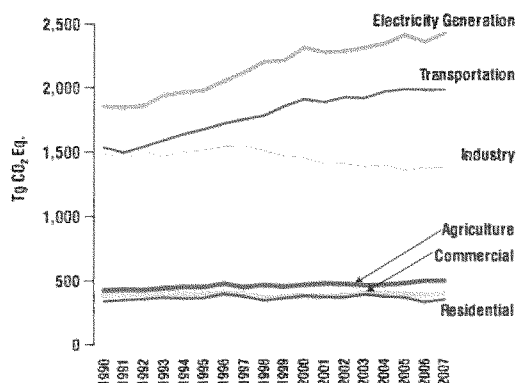
U.S. emissions increased by 1051.4 TgCO₂eq, or 17.2% between 1990 and 2007 (see Figure 2.1) (U.S. EPA, 2009b). Historically, changes in fossil fuel consumption have been the dominant factor affecting U.S. emission trends. The fundamental factors driving this trend include a generally growing domestic economy over the last 17 years, leading to overall growth in emissions from electricity generation (increase of 31.5%) and transportation activities (increase of 29.3%) (U.S. EPA, 2009b). Over the same time period, industrial sector emissions decreased by 7.3%, while residential, commercial, and agricultural sector emissions increased by 3.1%, 3.7%, and 17.3%, respectively (Figure 2.2) (U.S. EPA, 2009b).

U.S. Emissions of Selected Aerosols and Ozone Precursors

Aerosols are not GHGs but rather small, short-lived particles present in the atmosphere with widely varying size, concentration, and chemical composition. They can be directly emitted or formed in secondary reactions from emitted compounds. Aerosols are removed from the atmosphere primarily through cloud processing and wet deposition in precipitation, a mechanism that establishes average tropospheric aerosol atmospheric lifetimes at a week or less (CCSP, 2009a). Tropospheric ozone is a short-lived GHG produced largely by chemical reactions of precursor species in the atmosphere.

Aerosols and tropospheric ozone precursors do not have widely accepted GWP or CO₂ equivalent values but can still have significant impacts on regional and global climate. Four of the more important aerosols are sulfates, nitrates, organic carbon, and black carbon. Tropospheric ozone is not directly emitted but is a secondary product formed by atmospheric reactions from ozone precursors such as volatile organic compounds (VOCs) and nitrogen oxides (NO_x). While some aerosols are directly emitted, others are formed through secondary reactions (for example, sulfates and nitrates can be formed by oxidation of sulfur dioxide [SO₂] and NO_x respectively), and their properties can change as they mix and react in the atmosphere. In the United States, these substances have been controlled under a number of local, state, and federal regulations over the last several decades, either directly, for SO₂ by the Clean Air Act Amendments of 1990, among other legislation; or indirectly, for black and organic carbon as components of particulate matter (a criteria pollutant); for example through the 2007 Highway Diesel Rule or the National Ambient Air Quality (NAAQS) standards. The U.S. inventory does include SO₂ emissions, which were 5.9 Tg of sulfur (TgS) in 2007, a reduction from 10.5 TgS in 1990 (U.S. EPA, 2009b) and 12 TgS in 1980 (CCSP 2009a). EPA estimates that 0.44 TgS per year (yr⁻¹) of those emissions come from the transportation sector (U.S. EPA, 2009b). National inventories do not yet explicitly include black carbon or organic carbon: however, black carbon and organic carbon emissions can be derived from total fine particulate matter (PM_{2.5}) emissions, which were estimated to be 5.0 Tg in 2005. In that year, ammonia emissions were 3.7 Tg, and of the ozone precursors, NO_x emissions were estimated to be 18.5 Tg and VOC emissions were 16.8 Tg (U.S. EPA, 2009c). According to the EPA, U.S. emissions of SO_x, NO_x, direct particulates, and ozone precursors have decreased from 1990 to 2007 (U.S. EPA, 2008), and average concentrations of sulfates, nitrates, particulate matter, and ozone as measured at U.S. monitoring sites have all decreased between 1990 and 2007 (U.S. EPA, 2008).

Figure 2.2: U.S. GHG Emissions Allocated to Economic Sector



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (U.S. EPA, 2009b). All GHGs. Excludes land use, land-use change and forestry, emissions from U.S. territories and international bunker fuels.

U.S. Greenhouse Gas Emissions From Source Categories Under Section 202(a) of the Clean Air Act

Source categories under Section 202(a) of the Clean Air Act include passenger vehicles, light- and heavy-duty trucks, buses, motorcycles, and the cooling systems designed for passenger comfort, as well as auxiliary systems for refrigeration.

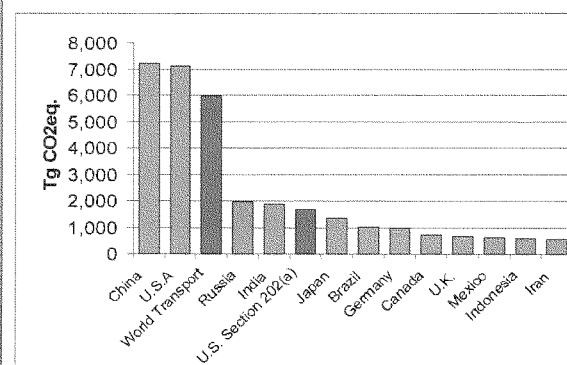
In 2007, Section 202(a) source categories collectively were the second largest GHG-emitting sector within the United States (behind the electricity generating sector), emitting 1,649 TgCO₂eq and representing 23% of total U.S. GHG emissions. Between 1990 and 2007, total GHG emissions from passenger cars decreased 2.6%, while emissions from light-duty trucks increased 59 percent, largely due to the increased use of sport-utility vehicles and other light-duty trucks.

Total global emissions are estimated by summing emissions of the six GHGs, by country. The World Resources Institute compiles data from recognized national and international data sources in its Climate Analysis Indicators Tool (CAIT).¹⁶ Globally, total GHG emissions were 38,725.9 TgCO₂eq in 2005, the most recent year for which data are available for *all* countries and *all* GHGs (WRI, 2009).¹⁷ This global total for the year 2005 represents an increase of about 26% from the 1990 global GHG emission total of 30,704.9 TgCO₂eq (WRI, 2009). Excluding land use, land-use change, and forestry, U.S. emissions were 18% of the total year 2005 global emissions (see Figure 2.3) (WRI, 2009).

Global Greenhouse Gas Emissions

Globally in 2005, Section 202(a) source category GHG emissions represented 28% of global transport GHG emissions and 4.3% of total global GHG emissions (Figure 2.3). The global transport sector was 15% of all global GHG emissions in 2005. If U.S. Section 202(a) source category GHG emissions were ranked against total GHG emissions for entire countries, U.S. Section 202(a) emissions would rank behind only China, the United States as a whole, Russia, and India, and would rank ahead of Japan, Brazil, Germany, and every other country in the world (Figure 2.3).

Figure 2.3: Total GHG Emissions for 2005 by Country and for U.S. Section 202a Source Categories



Source: WRI (2009). Available at <http://cait.wri.org/>. Excludes land use, land-use change and forestry, and international bunker fuels. More recent emission data are available for the United States and other individual countries, but 2005 is the most recent year for which data for all countries and all gases are available. Data accessed August 5, 2009. Refer to Appendix B for U.S. section 202a data and reference.

¹⁶ Primary data sources referenced in CAIT include the U.S. Department of Energy's Carbon Dioxide Information Analysis Center, EPA, the International Energy Agency, and the National Institute for Public Health and the Environment, an internationally recognized source of non-CO₂ data.

¹⁷ Source: WRI Climate Analysis and Indicators Tool. Available at <http://cait.wri.org/>.

Further detail on these emissions can be found in Appendix B of this document.

Global Emissions of Aerosols

Inventories of anthropogenic aerosol emissions are not regularly reported in most national climate inventories, and the uncertainties in inventory estimates tend to be larger than for GHGs, ranging from 15% for sulfur emissions to a factor of two for black carbon (Forster et al., 2007). CCSP (2009a) provided estimates for global emissions of black carbon, organic matter, and sulfur in the year 2000: 7.7 Tg yr⁻¹ of black carbon, 47 Tg yr⁻¹ of particulate organic matter, and 112.6 Tg yr⁻¹ of sulfur emissions (including SO₂ and particulate sulfate). Historically, particle emissions were high due to lack of particulate controls and use of biofuels, but more recently technological controls have led to reductions in particulate emissions from coal burning. Therefore, over the past century, emissions of particulates did not grow as fast as CO₂ emissions, as the latter are roughly proportional to total fuel use (CCSP, 2009a).

2(b) Lifetime of Greenhouse Gases in the Atmosphere

Greenhouse gas concentrations in the atmosphere are a function of both the emissions of the GHGs and the effective lifetime of these gases. Each gas has a characteristic lifetime that is a function of the total atmospheric burden and the removal mechanism (i.e., sinks) for that gas. Each GHG has different interactions of each gas with the various available sinks, which include chemical reaction with the hydroxyl (OH) free radical or other highly reactive species, photolysis by sunlight, dissolution into the oceans, reactions on the surface, biological processes, or other mechanisms. According to the IPCC, the lifetime of the HFCs of industrial importance range from 1.4 to 270 years, the lifetime of N₂O is 114 years, and the lifetime of the PFCs and SF₆ range from 1,000 to 50,000 years (Forster et al., 2007). The lifetime of CH₄ is more complicated: the atmospheric lifetime or residence time (the burden over the sink) is 8.7 years; however, emissions of CH₄ lead to consumption of the available OH sink, thereby increasing the lifetime for the remaining CH₄ in the atmosphere. Therefore, a “perturbation lifetime” of CH₄ that accounts for this effect is used for most purposes, and the IPCC reports the perturbation lifetime to be 12 years (Denman et al., 2007).

Carbon dioxide has a very different life cycle compared to the other GHGs, which have well-defined lifetimes. Instead, unlike the other gases, CO₂ is not destroyed by chemical, photolytic, or other reaction mechanisms, but rather the carbon in CO₂ cycles between different reservoirs in the atmosphere, ocean, land vegetation, soils, and sediments. There are large exchanges between these reservoirs, which are approximately balanced such that the net source or sink is near zero. Anthropogenic CO₂ emissions released through the use of fossil fuel combustion and cement production from geologically stored carbon (e.g., coal, oil, and natural gas) that is hundreds of millions of years old, as well as anthropogenic CO₂ emissions from land-use changes such as deforestation, perturb the atmospheric concentration of CO₂ and the distribution of carbon within different reservoirs readjusts. Carbon cycle models indicate that for a pulse of CO₂ emissions, given an equilibrium background, 50% of the atmospheric increase will disappear within 30 years, 30% within a few centuries, and the last 20% may remain in the atmosphere for thousands of years (Denman et al., 2007).

Because it takes one to two years to mix the emissions of a species throughout the troposphere, gases that are chemically stable and persist in the atmosphere over time scales of decades to centuries or longer are referred to in the IPCC as “long-lived” or “well-mixed” gases.

2(c) Historic and Current Global Greenhouse Gas Concentrations

Greenhouse gas concentrations in the atmosphere vary over very long time scales in response to natural influences such as geologic activity and temperature change associated with ice age cycles, but ice core data show nearly constant concentrations of CO₂, CH₄ and N₂O over more than 10,000 years prior to the Industrial Revolution. However, since the Industrial Revolution, anthropogenic GHG emissions have resulted in substantial increases in the concentrations of GHGs in the atmosphere (IPCC, 2007d; NRC, 2001a).

Carbon Dioxide (CO₂)

Carbon dioxide concentrations have increased substantially from pre-industrial levels (Figure 2.4). The long-term trends in the CO₂ concentrations are as follows (NOAA, 2009c; Forster et al., 2007; Karl et al., 2009):

- The CO₂ concentration has increased about 38% from a pre-industrial value of about 280 parts per million (ppm) to 385 ppm (which is about 0.039% of the atmosphere by volume) in 2008¹⁸.
- The present atmospheric concentration of CO₂ exceeds by far the natural range over the last 800,000 years (172 to 300 ppm) as determined from ice cores (Karl et al., 2009).
- The annual CO₂ concentration growth rate¹⁹ has been larger since 2000 (2000-2008 average: 1.9 ppm per year), than it was over the previous 20 years (1980-1999 average: 1.5 ppm per year) or since the beginning of continuous direct atmospheric measurements at Mauna Loa (1959–1999 average: 1.3 ppm per year) although there is year-to-year variability.

Almost all of the increase in the CO₂ concentration during the Industrial Era is due to anthropogenic emissions (Forster et al., 2007). Since the 1980s, about half of the anthropogenic emissions have been taken up by the terrestrial biosphere and the oceans, but observations demonstrate that these processes cannot remove all of the extra flux due to human activities. Historically, about half of the anthropogenic emissions have remained in the atmosphere. There is year-to-year variability in the fraction of fossil fuel emissions remaining in the atmosphere due to changes in land-atmosphere fluxes associated with El Niño Southern Oscillation (ENSO²⁰) and events such as the eruption of Pinatubo (Forster et al., 2007). The rate of emission of CO₂ currently exceeds its rate of removal, and the slow and incomplete removal implies that small to moderate reductions in its emissions would not result in stabilization of CO₂ concentrations but rather would only reduce the rate of its growth in coming decades (Meehl et al., 2007).

¹⁸ The 2008 value is preliminary.

¹⁹ The estimated uncertainty in the global annual mean growth rate at marine surface sites is 0.1010 ppm/yr, in the Mauna Loa growth rate it is 0.11 ppm/yr. The 2000-2008 average rate of change at Mauna Loa is 2.0 ppm/yr.

²⁰ ENSO describes the full range of the Southern Oscillation (a see-saw of atmospheric mass or pressure between the Pacific and Indo-Australian areas) that includes both sea surface temperature (SST) increases as well as SST decreases when compared to a long-term average. It has sometimes been used by scientists to relate only to the broader view of El Niño or the warm events, the warming of SSTs in the central and eastern equatorial Pacific. The acronym, ENSO, is composed of El Niño-Southern Oscillation, where El Niño is the oceanic component of the phenomenon, and the Southern Oscillation is the atmospheric component.

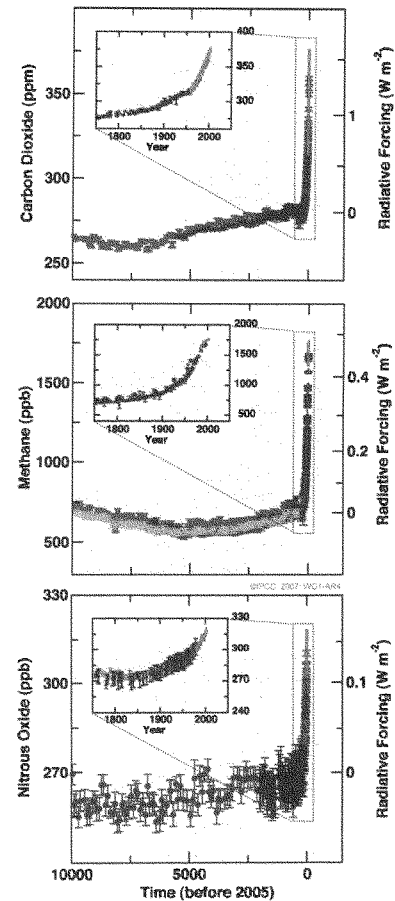
Methane (CH_4)

Methane concentrations have also risen substantially (Figure 2.4). The following trends in atmospheric methane have been observed according to the NOAA *State of the Climate* reports for 2007 and 2008 and IPCC (Horvitz, 2008; Peterson and Baringer, 2009; Forster et al., 2007):

- The global atmospheric concentration of methane has increased from a pre-industrial value of about 715 parts per billion (ppb) to 1732 ppb in the early 1990s, and was 1782 ppb in 2007—a 149% increase from pre-industrial levels.
- The atmospheric concentration of methane in 2007 exceeds by far the natural range of the last 650,000 years (320 to 790 ppb) as determined from ice cores (Jansen et al., 2007).
- Growth rates declined between the early 1990s and mid-2000s. The reasons for the decrease in the atmospheric CH_4 growth rate and the implications for future changes in its atmospheric burden are not well understood but are clearly related to the imbalances between CH_4 sources and sinks.

The methane concentration grew 7.5 ppb between 2006 and 2007, driven by increased emissions in both the Arctic and tropical regions likely caused by high temperatures and precipitation in wetland regions, particularly in the Arctic. Analysis of carbon monoxide measurements suggests little contribution from enhanced biomass burning. Methane concentrations grew again in 2008, with most of the increase driven by the tropics, the first consecutive year-to-year increases since 1998. The observed increase in methane concentration is very likely due to anthropogenic activities, predominantly agriculture and fossil fuel use, but relative contributions from different source types are not well determined (Forster et al., 2007).

Figure 2.4: Atmospheric Concentrations of Carbon Dioxide, Methane and Nitrous Oxide over the Last 10,000 Years



Source: IPCC (2007d). Atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colors for different studies) and atmospheric samples (red lines). The corresponding radiative forcings (discussed in Section 2(e)) are shown on the right-hand axes of the large panels.

Nitrous Oxide (N₂O)

The N₂O concentration has increased 23% from its pre-industrial value of 262 ppb (Figure 2.4) to 322 ppb in 2007 (Peterson and Baringer, 2009). The concentration has increased linearly by about 0.8 ppb yr⁻¹ over the past few decades and is due primarily to human activities, particularly agriculture and associated land-use change (Forster et al., 2007). Ice core data show that the present atmospheric concentration of N₂O exceeds levels measured in the ice core record of the past 650,000 years, with sufficient resolution to exclude a peak similar to the present for at least the past 16,000 years with very high confidence (Jansen et al., 2007).

Fluorinated Gases

The industrial fluorinated gases that serve as substitutes for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), such as HFCs, PFCs, and SF₆, have relatively low atmospheric concentrations. Concentrations of many of these gases increased by large factors (between 1.3 and 4.3) between 1998 and 2005. These gases are almost entirely anthropogenic in origin, although CF₄, which contributes 20% of the total forcing due to anthropogenic increases in these gases, has a natural source that accounts for about one-half of its current atmospheric content (Forster et al., 2007).

Ozone-depleting substances covered by the Montreal Protocol

Chlorofluorocarbons and HCFCs are GHGs that are entirely anthropogenic in origin. Emissions of these gases have decreased due to their phase-out under the Montreal Protocol, and the atmospheric concentrations of CFC-11 and CFC-113 are now decreasing due to natural removal processes (Forster et al., 2007). Ice core and in situ data confirm that industrial sources are the cause of observed atmospheric increases in CFCs and HCFCs (Forster et al., 2007).

Ozone (O₃)

Due to its short atmospheric life time, tropospheric ozone concentrations exhibit large spatial and temporal variability. Changes in tropospheric ozone also occur due to changes in transport of ozone across the tropopause (Forster et al., 2007). Relative to the other GHGs, there is less confidence in reproducing the changes in ozone associated with large changes in emissions or climate, and in the simulation of observed long-term trends in ozone concentrations over the 20th century (Forster et al., 2007).

Aerosols (Sulfates, Nitrates, Black Carbon, and Organic Carbon Aerosols)

On a global basis, aerosol mass derives predominantly from natural sources, mainly sea salt and dust. However, anthropogenic (manmade) aerosols, arising primarily from a variety of combustion sources, can dominate concentrations in and downwind of highly populated and industrialized regions and in areas of intense agricultural burning (CCSP, 2009a). Aerosol optical density trends observed in the satellite and surface-based data records suggest that since the mid-1990s, the amount of anthropogenic aerosol has decreased over North America and Europe, but has increased over parts of east and south Asia; on average, the atmospheric concentration of low-latitude smoke particles has increased, consistent with changes in emissions (CCSP, 2009a). Ice core data from Greenland and Northern Hemisphere mid-latitudes show a *very likely* rapid post-industrial era increase in sulfate concentrations above the preindustrial background, though in recent years, SO₂ emissions have decreased globally and in many regions of the Northern Hemisphere. In general, the concentration, composition, and distribution of aerosols in the paleoclimate record are not as well known as the long-lived GHGs (Jansen et al., 2007).

Part III

**Global and U.S. Observed and Projected Effects From Elevated
Greenhouse Gas Concentrations**

Section 3

Direct Effects of Elevated Greenhouse Gas Concentrations

Carbon dioxide and other GHGs can have direct effects that are independent of their radiative forcing on climate (the primary effect discussed throughout this document). Such effects are described in the following sections.

Effects on Human Health

Current and projected ambient GHG concentrations remain well below published thresholds for any direct adverse health effects, such as respiratory or toxic effects. The literature supporting this conclusion is described in Appendix C.

Effects on Plants and Carbon Dioxide Fertilization

Carbon dioxide can have a stimulatory or fertilization effect on plant growth. There is debate and uncertainty about the sensitivity of crop yields to the direct effects of elevated CO₂ levels. However, the IPCC (Easterling et al., 2007) confirmed the general conclusions from its previous *Third Assessment Report* in 2001 and concluded that elevated CO₂ levels are expected to result in small beneficial effects on crop yields. Experimental research on crop responses to elevated CO₂ through the FACE (Free Air CO₂ Enrichment)²¹ experiments indicate that, at ambient CO₂ concentrations of 550 ppm (approximately double the concentration from pre-industrial times) crop yields increase under unstressed conditions by 10 to 25% for C3 crops, and by 0 to 10% for C4 crops²² (medium confidence). Crop model simulations under elevated CO₂ are consistent with these ranges (high confidence) (Easterling et al., 2007). High temperatures and ozone exposure, however, could significantly limit the direct stimulatory CO₂ response (see also Section 8 on Air Quality and Section 9 on Food Production and Agriculture).

Studies have demonstrated increases in CO₂ effects water use and water use efficiency of plants. For example, elevated CO₂ causes partial stomatal closure, which decreases conductance, and reduces loss of water vapor from leaves to the atmosphere (Hatfield et al., 2008). Interpolating the results from several studies indicates that it is very likely that an increase in CO₂ concentration from 380 to 440 ppm will cause reductions in stomatal conductance on the order of 10% compared to today's values (Hatfield et al., 2008). Elevated CO₂ may affect forage quality for livestock, because it can increase the carbon-to-nitrogen ratio in forages, thus reducing the nutritional value of those grasses. This, in turn, can affect animal weight and performance. The decline under elevated CO₂ of C4 grasses, however, which are less nutritious than C3 grasses, may compensate for the reduced protein (Hatfield et al., 2008).

At much higher ambient CO₂ concentrations, such as those areas exposed to natural CO₂ outgassing due to volcanic activity, the main characteristic of long-term elevated CO₂ zones at the surface is the lack of vegetation (IPCC, 2005). New CO₂ releases into vegetated areas cause noticeable die-off. In those areas where significant impacts to vegetation have occurred, CO₂ makes up about 20 to 95% of the soil gas, whereas normal soil gas usually contains about 0.2 to 4% CO₂. Carbon dioxide concentrations above 5% may be dangerous for vegetation and as concentrations approach 20%, CO₂ becomes phytotoxic. Carbon

²¹ <http://www.bnl.gov/face/>

²² C3 and C4 refer to different carbon fixation pathways in plants during photosynthesis. C3 is the most common pathway, and C3 crops (e.g., wheat, soybeans, and rice) are more responsive to CO₂ enrichment than C4 crops such as maize.

dioxide can cause death of plants through “root anoxia,” together with low oxygen concentration (IPCC, 2005). No projections show CO₂ concentrations approaching these phytotoxic levels.

As concentrations of atmospheric CO₂ increase, more CO₂ is absorbed at the surface of oceans, estuaries, streams, and lakes. Increases in the amount of dissolved CO₂ and, for some species, bicarbonate ions (HCO₃⁻) present in aquatic environments will lead to higher rates of photosynthesis in submerged aquatic vegetation, similar to the fertilization effects of CO₂ enrichment on most terrestrial plants, if other limiting factors do not offset the potential for enhanced productivity. A study cited in Nicholls et al., (2007) indicates algal growth may also respond positively to elevated dissolved inorganic carbon (DIC), though marine macroalgae do not appear to be limited by DIC levels. An increase in epiphytic or suspended algae would decrease light available to submerged aquatic vegetation and also increase the incidence of algal blooms that lower dissolved oxygen available to fish and shellfish (Nicholls et al., 2007).

Ocean Acidification

According to the IPCC (Fischlin et al., 2007) elevated CO₂ concentrations are resulting in ocean acidification, which may affect marine ecosystems (medium confidence). This issue is discussed further in Sections 4h, 6b, and 14a.

Section 4

Radiative Forcing and Observed Climate Change

This section focuses primarily on the more significant effects associated with GHGs, which is their heat-trapping ability (referred to as radiative forcing) that results in climate change. Observed climate change is reviewed, including changes in temperature, precipitation, and sea level rise, for the globe and the United States. Observed changes in climate-sensitive physical and biological systems are also addressed, as well as observed trends in extreme events. Sections 7 to 16 provide more specific information on the sectoral implications of both the observed changes described here and the projected changes described in Section 6.

4(a) Radiative Forcing Due to Greenhouse Gases and Other Factors

This section describes radiative forcing and the factors that contribute to it. Radiative forcing is a measure of the change that a factor causes in altering the balance of incoming (solar) and outgoing (infrared and reflected shortwave) energy in the Earth-atmosphere system, and thus shows the relative importance of different factors in terms of their contribution to climate change. Positive forcing means the factor causes a warming effect, and negative forcing means the factor causes a cooling effect.

Radiative forcing values presented here for GHGs and other factors come from the IPCC *Fourth Assessment Report* of Working Group I (IPCC, 2007a). These radiative forcing values are the result of *global* changes in atmospheric concentrations of GHGs (see Section 2(c) above) and other factors, and are therefore not the result of U.S. transportation emissions in isolation. All values are for the year 2005 relative to pre-industrial times in 1750; represent global averages; and are expressed in watts per square meter²³ (W/m^2).

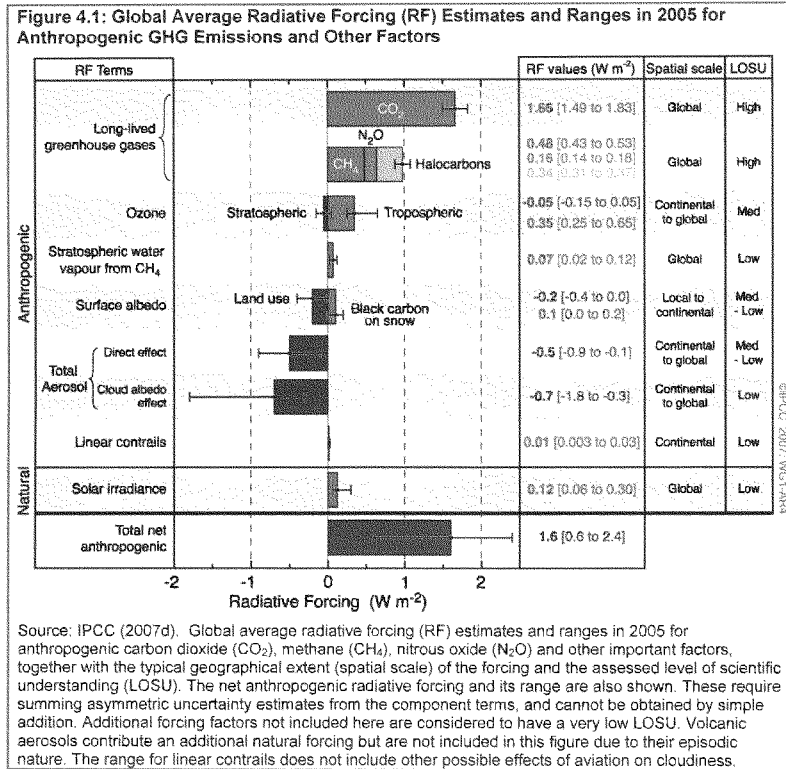
IPCC (2007d) concluded that the understanding of anthropogenic warming and cooling influences on climate has improved since the IPCC *Third Assessment Report*, leading to *very high confidence*²⁴ that the global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 (+0.6 to +2.4) W/m^2 .

Greenhouse gases have a positive forcing because they absorb and reradiate in all directions outgoing, infrared radiation that would otherwise directly escape into space. The combined radiative forcing due to the cumulative (i.e., 1750 to 2005) increase in atmospheric concentrations of CO_2 , CH_4 , and N_2O is +2.30 W/m^2 (with an uncertainty range of +2.07 to +2.53 W/m^2) (see Figure 4.1). This positive radiative forcing, like the observed accumulation of these gases in the atmosphere, is primarily anthropogenic in origin. Furthermore, the IPCC (2007d) stated that the rate of increase in positive radiative forcing due to these three GHGs during the industrial era is “very likely to have been unprecedented in more than 10,000 years.”

The positive radiative forcing due to CO_2 is the largest (+1.66 \pm 0.17 W/m^2) (Figure 4.1) and has increased by 20% from 1995 to 2005, the largest change for any decade in at least the last 200 years. Methane is the second largest source of positive radiative forcing (+0.48 \pm 0.05 W/m^2). Nitrous oxide has a positive radiative forcing of +0.16 (\pm 0.02) W/m^2 .

²³ Watts per square meter is the standard metric unit for radiative and other energy fluxes.

²⁴ According to IPCC terminology, “very high confidence” conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC’s uncertainty terms.



The other three GHGs reported by the U.S. Inventory—HFCs, PFCs and SF₆—have a total radiative forcing in 2005 of +0.017 (± 0.002) W/m², which is increasing by roughly 10% per year (Forster et al., 2007).

The ozone-depleting substances covered under the Montreal Protocol (CFCs, HCFCs, and chlorocarbons) are also strong GHGs and, as a group, contributed +0.32 (± 0.03) W/m² to anthropogenic radiative forcing in 2005. Their radiative forcing peaked in 2003 and is now beginning to decline (Forster et al., 2007). The radiative forcing due to the destruction of stratospheric ozone by these gases is estimated to be -0.05 ± 0.10 W/m² with a medium level of scientific understanding (Forster et al., 2007).

In addition to the six main GHGs directly emitted by human activities and the gases covered by the Montreal Protocol, there are additional anthropogenic and natural factors that contribute to both positive and negative forcing.

With regard to climate change, ozone affects the radiative budget of the atmosphere through its interaction with both shortwave and longwave radiation (Forster et al., 2007). Tropospheric ozone changes caused by emissions of ozone-forming chemicals, or precursors (nitrogen oxides, carbon monoxide, and hydrocarbons including methane), contribute a positive forcing of +0.35 (+0.25 to +0.65) W/m^2 . As described in CCSP (2008d), robust model simulations project climate change will also increase the radiative forcing from ozone by increasing stratosphere-troposphere exchange and hence ozone near the tropopause where it is most important radiatively. Unlike the GHGs mentioned previously, tropospheric ozone is not as well-mixed in the global atmosphere because its atmospheric lifetime is on the order of days to months (versus decades to centuries for the well-mixed GHGs). Tropospheric ozone is a criteria air pollutant under the U.S. Clean Air Act.

Emissions of ozone precursors and other substances also contribute to changes in levels of the reactive gas OH. OH is the major oxidizing chemical in the atmosphere, destroying significant quantities of many non- CO_2 GHGs (e.g., CH_4 , HFCs, HCFCs, and ozone) thus influencing their chemical lifetimes and radiative forcing; it also plays an important role in the formation of sulfate, nitrate, and some organic aerosol species (Forster et al., 2007).

Anthropogenic emissions of aerosols contribute to both positive and negative radiative forcing. Aerosols are non-gaseous substances other than water or ice that are suspended in the atmosphere and are either solid particles or liquid droplets. Most aerosols, such as sulfates (which are mainly the result of SO_2 emissions from fossil fuel burning), exert a negative forcing or cooling effect, as they reflect and scatter incoming solar radiation. Some aerosols, such as black carbon, cause a positive forcing by absorbing incoming solar radiation. IPCC (2007d) estimated that the net effect of all anthropogenic increases in aerosols (primarily sulfate, organic carbon, black carbon, nitrate, and dust) produce a cooling effect, with a total direct radiative forcing of -0.5 (-0.9 to -0.1) W/m^2 and an additional indirect cloud albedo (i.e., enhanced reflectivity)²⁵ forcing of -0.7 (-1.8 to -0.3) W/m^2 . Understanding of these forcings has improved since the IPCC *Third Assessment Report* (IPCC, 2001c) but nevertheless remain the dominant uncertainty in radiative forcing (IPCC, 2007d).

The direct radiative forcing of the individual aerosol species is less certain than the total direct aerosol radiative forcing. The estimates are: sulfate, -0.4 (± 0.2) W/m^2 ; fossil fuel organic carbon, -0.05 (± 0.05) W/m^2 ; fossil fuel black carbon, $+0.2$ (± 0.15) W/m^2 ; biomass burning, $+0.03$ (± 0.12) W/m^2 ; nitrate, -0.1 (± 0.1) W/m^2 ; and mineral dust, -0.1 (± 0.2) W/m^2 . Including both fossil fuel and biomass burning sources, the total black carbon aerosol forcing is estimated to be 0.34 (0.09 to 0.59) W/m^2 . In addition, black carbon can cause another positive radiative forcing effect ($+0.1$ (0.0 to $+0.2$) W/m^2) by decreasing the surface albedo of snow and ice, although scientific understanding of this forcing is low (Forster et al., 2007), with implications for Arctic and glacial melt. Also, according to the CCSP (2009a), since aerosol forcing is much more pronounced on regional scales than on the global scale because of the highly variable aerosol distributions, it would be insufficient or even misleading to place too much emphasis on the global average, with effects being dependent on both the location and timing of the emissions. Aerosols can alter the atmospheric circulation patterns and water cycles due to the manner in which aerosols can heat the atmosphere and cool the surface as well as to various cloud interactions (CCSP, 2009a). The total forcing associated with anthropogenic aerosols is less certain than that for GHGs, due to the indirect effects of aerosols, including cloud formation and albedo change.

²⁵ In addition to directly reflecting solar radiation, aerosols cause an additional, indirect negative forcing effect by enhancing cloud albedo (a measure of reflectivity or brightness). This effect occurs because aerosols act as particles around which cloud droplets can form; an increase in the number of aerosol particles leads to a greater number of smaller cloud droplets, which leads to enhanced cloud albedo. Aerosols also influence cloud lifetime and precipitation, but no central estimates of these indirect forcing effects are estimated by IPCC. These aerosol indirect effects remain some of the biggest uncertainties of the climate forcing/feedback processes (CCSP, 2009a).

The radiative forcing from increases in stratospheric water vapor due to oxidation of anthropogenic increases in CH₄ is estimated to be $+0.07 \pm 0.05$ W/m² (Forster et al., 2007). The level of scientific understanding is low because the contribution of CH₄ to the corresponding vertical structure of the water vapor change near the tropopause is uncertain.

Changes in surface albedo due to human-induced land cover changes exert a forcing of -0.2 (-0.4 to 0.0) W/m². Changes in solar irradiance since 1750 are estimated to cause a radiative forcing of $+0.12$ ($+0.06$ to $+0.30$) W/m². This estimate is less than half of the estimate given in IPCC's *Third Assessment Report* (2001), with a low level of scientific understanding (Forster et al., 2007). Uncertainties remain large because of the lack of direct observations and incomplete understanding of solar variability mechanisms over long time scales. Empirical associations have been reported between solar-modulated cosmic ray ionization of the atmosphere and global average low-level cloud cover, but evidence for a systematic indirect solar effect remains ambiguous. The lack of a proven physical mechanism and the plausibility of other causal factors make the association between galactic cosmic ray-induced changes in aerosol and cloud formation controversial (Forster et al., 2007).

Although water vapor is the most important and abundant GHG in the atmosphere, human activities produce only a very small direct increase in tropospheric water vapor (Karl et al., 2009). Irrigation and deforestation both have small, poorly understood effects on humidity, in opposite directions, and the IPCC concluded that radiative forcing from these sources of tropospheric water vapor is smaller than their non-radiative effects (such as evaporative cooling). Emissions of water vapor from combustion processes are significantly lower than emissions from land use; hence the absence of water vapor in Figure 4.1 (Forster et al., 2007). As temperatures increase, however, tropospheric water vapor concentrations also increase, representing a key positive feedback (e.g., one that enhances warming) but not a forcing of climate change (Solomon et al., 2007). Feedbacks are defined as processes in the climate system (such as a change in water vapor concentrations) that can either amplify or dampen the system's initial response to radiative forcing changes (NRC, 2005).

4(b) Global Changes in Temperature

Multiple lines of evidence lead to the robust conclusion that the climate system is warming. The IPCC (2007d) stated in its *Fourth Assessment Report*:

“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.”

This finding was reaffirmed in the U.S. Global Change Research Program's June 2009 report *Global Climate Change Impacts in the United States* (Karl et al., 2009).

Air temperature is a main property of climate and the most easily measured, directly observable, and geographically consistent indicator of climate change. The extent to which observed changes in global and continental temperature and other climate factors can be attributed to anthropogenic emissions of GHGs is addressed in Section 5.

Global Surface Temperatures

Surface temperature is calculated by processing data from thousands of worldwide observation sites on land and sea. Substantial gaps in data coverage remain, especially in the tropics and the Southern Hemisphere, particularly Antarctica, although data coverage has improved with time. These gaps are

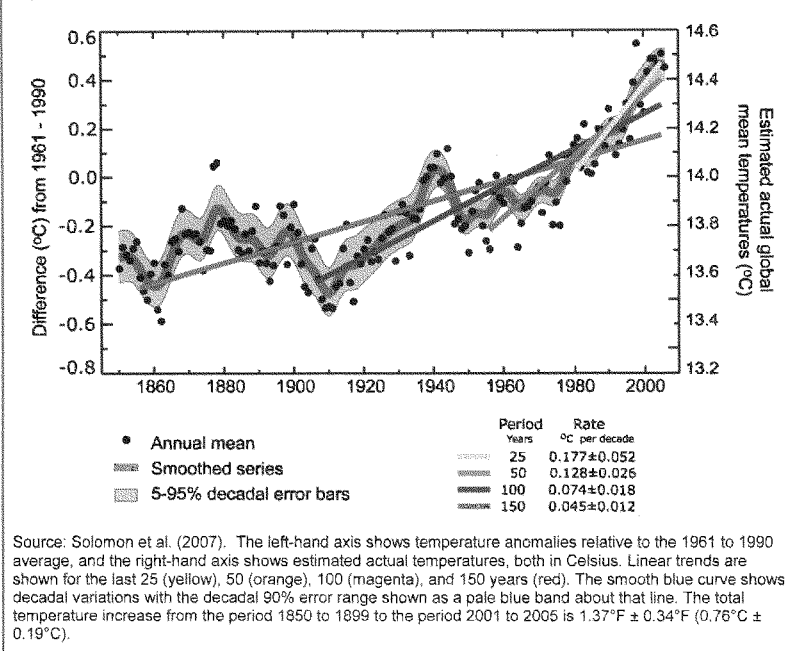
largest in the 19th century and during the two world wars (Trenberth et al., 2007). The long-term mean temperatures are calculated by interpolating within areas with no measurements using the collected data available. Mears et al. (2006) caution: “For regions with either poor coverage or data gaps, trends in surface air temperature should be regarded with considerable caution, but do not have serious effects on the largest of scales as most of the variability is well sampled.”

Biases may exist in surface temperatures due to changes in station exposure and instrumentation over land, or changes in measurement techniques by ships and buoys in the ocean. It is likely that these biases are largely random and therefore cancel out over large regions such as the globe or tropics (Wigley et al., 2006). Likewise, urban heat island effects are real but local, and have not biased the large-scale trends (Trenberth et al., 2007). However, it is conceivable that systematic changes in many station exposures of a similar kind may exist over the land during the last few decades. If such changes exist, they may lead to small amounts of spurious cooling or warming, even when the data are averaged over large land areas (Mears et al., 2006).

The following trends in global surface temperatures were observed for the period 1850 to 2005, according to the IPCC (Trenberth et al., 2007):

- Global mean surface temperatures have risen by $1.3 \pm 0.3^\circ\text{F}$ ($0.74 \pm 0.18^\circ\text{C}$) when estimated by a linear trend over the last 100 years (1906–2005) as shown by the magenta line in Figure 4.2. The warmest years in the instrumental record of global surface temperatures are 1998 and 2005, with 1998 ranking first in one estimate, but with 2005 slightly higher in the other two estimates. 2002 to 2004 are the third, fourth, and fifth warmest years in the series since 1850. Eleven of the last 12 years (1995 to 2006) – the exception being 1996 – rank among the 12 warmest years on record since 1850. Temperatures in 2006 were similar to the average of the past five years.
- The warming has not been steady, as shown in Figure 4.2. Two periods of warming stand out: an increase of 0.63°F (0.35°C) that occurred from the 1910s to the 1940s and then a warming of about 0.99°F (0.55°C) from the 1970s up to the end of 2006. In between those two periods (from the 1940s to the 1970s), temperatures leveled off or cooled slightly. The remainder of the past 150 years has included short periods of both cooling and warming. The rate of warming over the last 50 years is almost double that over the last 100 years $0.23 \pm 0.05^\circ\text{F}$ vs. $0.13 \pm 0.04^\circ\text{F}$ ($0.13 \pm 0.03^\circ\text{C}$ vs. $0.07 \pm 0.02^\circ\text{C}$) per decade.
- Land regions have warmed at a faster rate than oceans. Warming has occurred in both land and oceans and in both sea surface temperature (SST) and nighttime marine air temperature over the oceans. However, for the globe as a whole, surface air temperatures over land have risen at about double the ocean rate after 1979 (more than 0.49°F [0.27°C] per decade vs. 0.23°F [0.13°C] per decade), with the greatest warming during winter (December to February) and spring (March to May) in the Northern Hemisphere. Recent warming is strongly evident at all latitudes in SSTs over each of the oceans.
- Average Arctic temperatures increased at almost twice the global average rate in the past 100 years. Arctic temperatures have high decadal variability. A slightly longer warm period, almost as warm as the present, was also observed from the late 1920s to the early 1950s, but appears to have had a different spatial distribution than the recent warming.

Figure 4.2: Annual Global Mean Temperatures (black dots) with Linear Fits to the Data.



- Between 1901 and 2005, statistically significant warming was observed over most of the world's surface with the exception of an area south of Greenland and three smaller regions over the southeastern United States and parts of Bolivia and the Congo basin. The lack of significant warming at about 20% of the locations and the enhanced warming in other places, is likely to be a result of changes in atmospheric circulation. Warming is strongest over the continental interiors of Asia and northwestern North America and over some mid-latitude ocean regions of the Southern Hemisphere as well as southeastern Brazil.
- Since 1979, warming has been strongest over western North America; northern Europe and China in winter; Europe and northern and eastern Asia in spring; Europe and North Africa in summer; and northern North America, Greenland, and eastern Asia in autumn.

Box 4.1: Updated Global Surface Temperature Trends Through 2008

The global surface temperature trend analysis in IPCC (2007a) includes data through 2005 from the United Kingdom's Hadley Centre (Hadley Centre, 2009), referred to as HadCRUT. Three additional years of data have become available since then (2006-2008) and two additional global surface temperature datasets are available for

comparison. The updated HadCRUT dataset²⁶ (which spans 1850-2008), NOAA's Merged Land-Ocean Surface Temperature dataset²⁷ (which spans 1880-2008) (NOAA, 2009a), and NASA's Global Surface Temperature dataset²⁸ (which spans 1880-2008), (NASA, 2009) all indicate:

- Eight of the 10 warmest years on record have occurred since 2001
- The 10 warmest years have all occurred in the past 12 years
- The 20 warmest years have all occurred since 1981

2008 was the ninth warmest year on record globally for the NOAA and NASA datasets and the 10th warmest year on record for the HadCRUT dataset. The warmest year on record was 2005 for the NOAA and NASA datasets and 1998 for the HadCRUT dataset.

Because trends may be sensitive to the choice of start date in a time series, it is instructive to analyze trends when varying these dates. The following table shows warming trends²⁹ starting in 1880 (when data is available across all three datasets) at 20 year intervals for all three datasets:

Period	HadCRUT	NOAA	NASA
1880-2008	0.11°F (0.061°C) /decade	0.10°F (0.056°C) /decade	0.10°F (0.056°C) /decade
1900-2008	0.13°F (0.072°C) /decade	0.13°F (0.072°C) /decade	0.12°F (0.067°C) /decade
1920-2008	0.13°F (0.072°C) /decade	0.12°F (0.067°C) /decade	0.12°F (0.067°C) /decade
1940-2008	0.15°F (0.083°C) /decade	0.15°F (0.083°C) /decade	0.14°F (0.078°C) /decade
1960-2008	0.25°F (0.14°C) /decade	0.24°F (0.13°C) /decade	0.24°F (0.13°C) /decade
1980-2008	0.29°F (0.16°C) /decade	0.30°F (0.17°C) /decade	0.29°F (0.16°C) /decade

These trends show strong agreement among the three datasets, a conclusion also drawn in CCSP (2006), Trenberth et al. (2007), and the NOAA study, "State of the Climate in 2008" (Peterson and Baringer, 2009). The warming rate in the last 10 30-year periods (averaging about 0.30°F [0.17°C] per decade) is the greatest in the observed record, followed closely by the warming rate (averaging about 0.25°F [0.14°C] per decade) observed during a number of 30-year periods spanning the 1910s to the 1940s.

Though most of the warmest years on record have occurred in the last decade in all available datasets, according to an analysis of the HadCRUT dataset in the "State of the Climate in 2008" report (Peterson and Baringer, 2009), the rate of warming has, for a short time, slowed. The temperature trend calculated for January 1999 to December 2008 was about +0.13 ± 0.13°F (+0.07 ± 0.07°C) per decade, which is less than the 0.32°F (0.18°C) per decade trend recorded between 1979 and 2005 (or 0.30°F [0.17°C] per decade for 1980 to 2008 as stated above). However, NOAA (NOAA, 2009a) and NASA (NASA, 2009) trends do not show the same marked slowdown for the 1999-2008 period. The NOAA trend was -0.21°F (0.12°C) per decade while the NASA trend was -0.34°F (0.19°C) per decade. The variability among datasets is a reflection of fewer data points and some differences in dataset methodologies. Analysis of trends for the years 2000, 2001, and 2002 through 2008 indicate a rather flat trend, with slight warming or cooling depending on choice of dataset and start date. It is important to recognize that year-to-year fluctuations in natural weather and climate patterns can produce a period that does not follow the long-term trend (Karl et al., 2009). Thus, each year will not necessarily be warmer than every year before it, though the long-term warming trend continues (Karl et al., 2009). For a discussion of how recent temperature trends relate to future climate projections, refer to Section 6b.

²⁶ Downloadable from: <http://cdiac.ornl.gov/ftp/trends/temp/jonescru/global.dat>

²⁷ Downloadable from: ftp://ftp.ncdc.noaa.gov/pub/data/anomalies/annual.land_ocean.90S.90N.df_1901-2000mean.dat

²⁸ Downloadable from: <http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts+dSST.txt>

²⁹ The trends in this table do not provide uncertainty estimates and are, therefore, approximate. In Trenberth et al. (2007), the uncertainty is given for these three datasets for different time periods in Table 3.3 and is about ±0.03°F (± 0.017°C) for 1901-2005 and ±0.09°F (± 0.05°C) for 1979-2005. These uncertainty estimates could reasonably be interpolated to the time series in this table.

Temperature trend analysis over Antarctica is complicated due to large regional and interannual variability and sparse data coverage. Recent studies and assessments have led to some different conclusions. Trenberth et al. (2007) indicate cooling over most of interior Antarctica and strong warming over the peninsula. However, the NOAA report *State of the Climate in 2008* (Peterson and Baringer, 2009) refers to a recent study that finds Antarctic warming is much broader in spatial extent, extending to include West Antarctica. Alternatively, it refers to another study that indicates little change in near-surface temperatures during the past 50 years over most of the continent despite finding marked warming over the Antarctic Peninsula.

Global Upper Air Temperatures

Temperature measurements have also been made above the Earth's surface over the past 50 to 60 years using radiosondes (balloon-borne instruments) and for the past 28 years using satellites. These measurements support the analysis of trends and variability in the troposphere (surface to 6.2 to 10 mi [10 to 16 kilometers, km]) and stratosphere 6.2 to 31 mi [10 to 50 km] above the Earth's surface).

The CCSP prepared a report that assessed temperature changes in the atmosphere, differences in the changes at various levels in the atmosphere, and an explanation of the causes of these changes and differences. It concluded (Wigley et al., 2006): "...the most recent versions of all available data sets show that both the surface and troposphere have warmed, while the stratosphere has cooled. These changes are in accord with our understanding of the effects of radiative forcing agents and with the results from model simulations."

The IPCC (Trenberth et al., 2007) reaffirmed the major conclusions of this CCSP report finding:

- New analyses of radiosondes and satellite measurements of lower- and mid-tropospheric temperature show warming rates that are similar to those of the surface temperature record and are consistent within their respective uncertainties.
- The satellite tropospheric temperature record is broadly consistent with surface temperature trends. The range (due to different data sets) of global surface warming since 1979 is 0.29°F (0.16°C) to 0.32°F (0.18°C) per decade compared to 0.22°F (0.12°C) to 0.34°F (0.19°C) per decade for estimates of tropospheric temperatures measured by satellite.
- Lower-tropospheric temperatures measured by radiosondes have slightly greater warming rates than those at the surface over the period 1958 to 2005. The radiosonde record is markedly less spatially complete than the surface record and increasing evidence suggests that it is very likely that a number of records have a cooling bias, especially in the tropics.

Lower stratospheric temperatures have cooled since 1979. Estimates from adjusted radiosondes, satellites, and re-analyses are in qualitative agreement, suggesting a lower-stratospheric cooling of between 0.5°F (0.3°C) and 1°F (0.6°C) per decade since 1979.

The global upper air temperature trend analysis in IPCC (2007a) described above includes data through 2005. Three additional years of data have become available since then (2006–2008). The addition of these three years does not significantly alter the above trends. For example, in NOAA (2009b) the satellite mid-tropospheric temperature trend computed for 1979–2008 ranges from +0.20 to 0.27°F (+0.11°C to +0.15°C) per decade compared to the estimate of +0.22 to +0.34°F (+0.12°C to +0.19°C) per decade given in IPCC (2007a). Combining the radiosonde and satellite records of the troposphere, the

State of the Climate in 2008 report estimates the trend is $+0.261 \pm 0.04^\circ\text{F}$ ($+0.145 \pm 0.02^\circ\text{C}$) per decade for the period 1958–2008 with the range of the trends calculated from the various datasets (Peterson and Baringer, 2009). The report notes there is no indication of acceleration of the trend. As in the surface temperature data, the trend over the last seven to 10 years in these data is relatively flat, but this does not fundamentally alter the longer term warming signal.

The 2008 annual average temperature of the lower stratosphere was similar to that of the last dozen years according to the *State of the Climate in 2008* report (Peterson and Baringer, 2009). The report notes that globally the lower stratosphere has been about 2.7°F (1.5°C) cooler over the past decade than in the 1960s when the radiosonde network began to offer reasonable global monitoring. It finds the general evolution of global lower stratospheric temperature is robustly captured in all available radiosonde (1958–present) and satellite (1979–present) datasets. However, the datasets differ in detail. For example, of those that cover 1979–2008, 2008 ranks as the coldest year in three, the second coldest in one, and the eighth coldest in another (Peterson and Baringer, 2009).

Global Surface Temperatures Over the Last 2,000 Years

Instrumental surface temperature records only began in the late 19th century, when a sufficiently large global network of measurements was in place to reliably compute global mean temperatures. To estimate temperatures further back in time, scientists analyze proxy evidence from sources such as tree rings, corals, ocean and lake sediments, cave deposits, ice cores, boreholes, glaciers, and documentary evidence. A longer temperature record can help place the 20th century warming into a historical context.

NRC conducted a study to describe and assess the state of scientific efforts to reconstruct surface temperature records for the Earth over approximately the last 2,000 years and the implications of these efforts for understanding global climate change. It found (NRC, 2006b):

- Large-scale surface temperature reconstructions, as illustrated in Figure 4.3, yield a generally consistent picture of temperature trends during the preceding millennium, including relatively warm conditions centered around 1000 A.D. (identified by some as the “Medieval Warm Period”) and a relatively cold period (or “Little Ice Age”) centered around 1700.
- It can be said with a high level of confidence that global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries. The observed warming in the instrumental record shown in Figure 4.2 supports this conclusion.
- Less confidence can be placed in large-scale surface temperature reconstructions for the period from 900 to 1600 A.D. Presently available proxy evidence indicates that temperatures at many, but not all, individual locations were higher during the past 25 years than during any period of comparable length since 900 A.D. The uncertainties associated with reconstructing hemispheric mean or global mean temperatures from these data increase substantially backward in time through this period and are not yet fully quantified.

- Very little confidence can be assigned to statements concerning the hemispheric mean or global mean surface temperature prior to about 900 A.D. because of sparse data coverage and because the uncertainties associated with proxy data and the methods used to analyze and combine them are larger than during more recent time periods.

Considering this study and additional research, the IPCC (2007d) concluded: "Paleoclimatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1,300 years." However, like NRC (2006b), IPCC

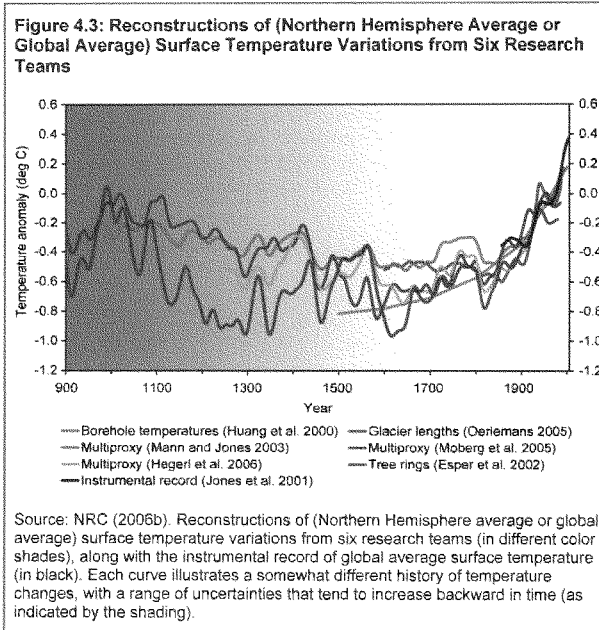
cautions that uncertainty is significant prior to 1600 (Jansen et al., 2007).

4(c) U.S. Changes in Temperature

Like global mean temperatures, U.S. temperatures also warmed during the 20th and into the 21st century. According to NOAA (2009e) and data from NOAA³⁰:

- U.S. average annual temperatures (for the contiguous United States or lower 48 states) are now approximately 1.25°F (0.69°C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. The rate of warming for the entire period of record (1901–2008) is 0.13°F (0.072°C) per decade while the rate of warming increased to 0.58°F (0.32°C) per decade for the period 1979–2008.
- 2005, 2006, and 2007 were exceptionally warm years (among the top 10 warmest on record), while 2008 was slightly warmer than average (the 39th warmest year on record), 0.2°F (0.1°C) above the 20th century (1901–2000) mean (though 0.06°F (0.035°C) below the 1971–2000 mean).

³⁰ Data for contiguous U.S. temperature time series analysis obtained from NOAA's National Climatic Data Center (NCDC). Data may be downloaded from: <http://www.epa.gov/climatechange/endangerment/data.html> (see file: us-temps-time-series-1901-2008-noaa.pdf).



- The last 10 five-year periods (2004–2008, 2003–2007, 2002–2006, 2001–2005, 2000–2004, 1999–2003, 1998–2002, 1997–2001, 1996–2000, and 1995–1999), were the warmest five-year periods (i.e., pentads) in the period of record (since 1901), demonstrating the anomalous warmth of the last 15 years.

NASA's U.S. temperature dataset³¹ for the lower 48 states indicates a somewhat lower warming trend (relative to NOAA) of 0.079°F (0.044°C) per decade for the period 1901–2008. But this warming trend increases to 0.47°F (0.26°C) per decade for the period 1979–2008 and the last eight five-year periods have been among the 10 warmest five-year periods on record. 1998 and 1934 are tied for the warmest year in NASA's U.S. record.

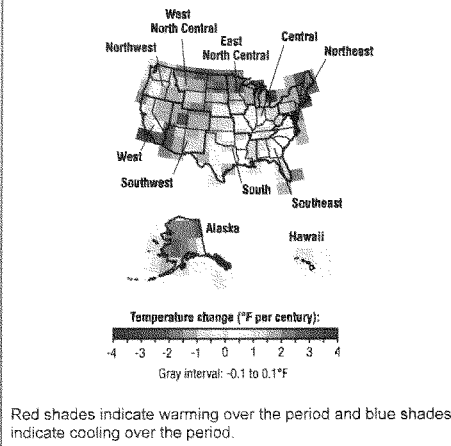
Over the past 50 years, Karl et al. (2009) report the U.S. average temperature has risen more than 2°F (1°C) over the past 50 years resulting in longer warm seasons and shorter, less-intense cold seasons.

Regional data³³ analyzed from NOAA through 2008, as illustrated in Figure 4.4, indicate warming has occurred throughout most of the United States, with all but four of the 11 climate regions showing an increase of more than 1°F (0.6°C) since 1901 (NOAA, 2009d). As shown in Figure 4.4, the greatest temperature increase occurred in Alaska (for the period 1918–2008) and the Northeast (1.9°F [1.06°C] and 2.0°F [1.1°C] per century, respectively). The least warming occurred in the Southeast, where the trend was 0.26°F (0.14°C) per century.

Including all of North America in its assessment of regional temperatures, the IPCC (Field et al., 2007) stated:

- For the period 1955–2005, the greatest warming occurred in Alaska and northwestern Canada, with substantial warming in the continental interior and modest warming in the southeastern United States and eastern Canada.
- Spring and winter show the greatest changes in temperature and daily minimum (nighttime) temperatures have warmed more than daily maximum (daytime) temperatures.

Figure 4.4: Map of the United States, Depicting Regional U.S. Temperature Trends for the Period 1901 to 2008³²



³¹ NASA U.S. temperature data may be downloaded from: <http://data.giss.nasa.gov/gistemp/graphs/fig.D.txt>.

³² Data for U.S. temperature map obtained from NOAA's NCDC. Data may be downloaded from: <http://www.epa.gov/climatechange/endangerment/data.html> (see file: us-temps-map-fig4-4-1901-2008-noaa.pdf).

³³ Data for U.S. regional temperature time series analysis obtained from NOAA's NCDC. Data may be downloaded from: <http://www.epa.gov/climatechange/endangerment/data.html> (see file: us-regional-temps-time-series-1901-2008-noaa.pdf).

4(d) Global Changes in Precipitation

A consequence of rising temperature is increased evaporation, provided that adequate surface moisture is available (e.g., over the oceans and other moist surfaces). The average atmospheric water vapor content has increased since at least the 1980s over land and ocean, as well as in the upper troposphere (IPCC, 2007d). When evaporation increases, more water vapor is available for precipitation producing weather systems leading to precipitation increases in some areas. Conversely, enhanced evaporation and evapotranspiration from warming accelerates land surface drying and increases the potential incidence and severity of droughts in other areas.

Observations show that changes are occurring in the amount, intensity, frequency, and type of precipitation. Cautioning that precipitation is highly variable spatially and temporally, and data are limited in some regions, the IPCC highlighted the following trends (Trenberth et al., 2007):

- Long-term trends from 1900 to 2005 have been observed in precipitation amount over many large regions. Significantly increased precipitation has been observed in eastern parts of North and South America, northern Europe, and northern and central Asia.
- Drying has been observed in northern Africa, southern Eurasia, Canada, and Alaska (Trenberth et al., 2007). The IPCC notes the trend towards drying in northern Africa and the Sahel region, with a partial recovery since 1990, has been a common feature of climate in these regions in the paleoclimate record (Jansen et al., 2007).
- For 1961–1990, rising temperature have generally resulted in rain rather than snow in locations and seasons where climatological average temperatures were close to 32°F (0°C).

The trends described in the NOAA report *State of the Climate in 2008* (Peterson and Baringer, 2009) are largely consistent with the IPCC. The NOAA report finds on a century time scale, most of the globe has trended towards wetter conditions, and particularly the northern high latitudes. But it also finds notable exceptions. A trend towards drier conditions is found over the tropics and some other locations. These include parts of southern Europe, most of Africa (while noting the drying trend over the Sahel reversed in 1989), southwestern Australia, and the west coast of South America. It highlights two regions that have become significantly drier over the past two decades: the southwestern United States and southeastern Australia.

For information on changes in global precipitation extremes (heavy precipitation and drought), see Section 4(k).

4(e) U.S. Changes in Precipitation

Data³⁵ analyzed from NOAA show that over the contiguous United States, total annual precipitation increased at an average rate of 6.1% per century from 1901–2008, and about 5% over the last 50 years (Karl et al., 2009). As shown in Figure 4.5 displaying regional data³⁶, the greatest increases in precipitation were in the East North Central climate region (9.6% per century), the Northeast (9.8% per century) and the South (10.5%). Precipitation increased in the Southeast by 1.3%, the Central United States by 7.2%, the West North Central by 4.0%, the Southwest by 3.7%, the West by 3.8%, and the Northwest by 4.1%.

Outside the contiguous United States, Hawaii experienced a decrease of 5.4% per century (since records begin in 1905). Precipitation over Alaska (not shown due to limited data coverage) has a decreasing long-term trend, but with significant variability over time and space.

Despite the overall national trend towards wetter conditions, a severe drought has affected the southwest United States from 1999 through 2008 (see Section 4(l)), which is indicative of significant variability in regional precipitation patterns over time and space.

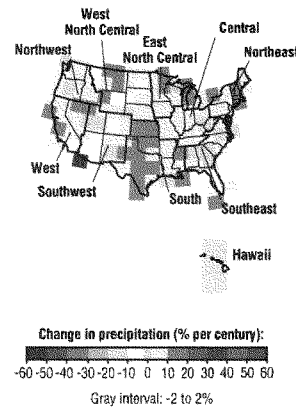
4(f) Global Sea Level Rise and Ocean Heat Content

Global Sea Level Rise

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate, after a period of little change between AD 0 and AD 1900 (IPCC, 2007a).

According to Bindoff et al. (2007), there is high confidence that the rate of sea level rise increased between the mid-19th and mid-20th centuries. The average rate of sea level rise measured by tide gauges from 1961 to 2003 was 0.071 ± 0.02 inch (0.18 ± 0.05 cm) per year (Bindoff et al., 2007). The global average rate of sea level rise measured by satellite altimetry during 1993 to 2003 was 0.12 ± 0.03 inch (0.31 ± 0.07 cm) per year (Bindoff et al., 2007). Coastal tide gauge measurements confirm this observation. It is unclear whether the faster rate for 1993 to 2003 is a reflection of short-term variability

Figure 4.5: Map of the United States, Depicting Precipitation Trends for the Contiguous United States 1901-2008 and Hawaii 1905-2008³⁴



Green shades indicate a trend toward wetter conditions over the period, and brown shades indicate a trend toward dryer conditions. No data are available for areas shaded white.

³⁴ Data for U.S. precipitation map obtained from NOAA's NCDC. Data may be downloaded from: <http://www.epa.gov/climatechange/endangerment/data.html> (see file: us-precip-map-fig4-5-1901-2008-noaa.pdf).

³⁵ Data for contiguous U.S. precipitation time series analysis obtained from NOAA's National Climatic Data Center. Data may be downloaded from: <http://www.epa.gov/climatechange/endangerment/data.html> (see file: us-precip-time-series-1901-2008-noaa.pdf).

³⁶ Data for U.S. regional precipitation time series analysis obtained from NOAA's National Climatic Data Center. Data may be downloaded from: <http://www.epa.gov/climatechange/endangerment/data.html> (see file: us-regional-precip-time-series-1901-2008-noaa.pdf).

or an increase in the longer-term trend (Bindoff et al., 2007). The total 20th century sea level rise is estimated to be 6.7 ± 2 inches (17 ± 5 cm) (Bindoff et al., 2007). Sources of uncertainty in measuring global average sea level rise include the adjustment for vertical land movements in tide gauge data and the proper accounting for instrumental bias and drifts in satellite altimetry data (Bindoff et al., 2007).

Two major processes lead to changes in global mean sea level on decadal and longer time scales: i) thermal expansion, and ii) the exchange of water between oceans and other reservoirs (glaciers and ice caps, ice sheets, and other land water reservoirs). It is believed that on average, over the period from 1961 to 2003, thermal expansion contributed about one-quarter of the observed sea level rise, while melting of land ice accounted for less than half; the full magnitude of the observed sea level rise was not satisfactorily explained by the available data sets (Bindoff et al., 2007). During this period, global ocean temperature rose by 0.18°F (0.10°C) from the surface to a depth of 2,300 ft (700 m), contributing an average of 0.016 ± 0.004 inch (0.04 ± 0.01 cm) yr^{-1} to sea level rise (Bindoff et al., 2007). The contribution from ice was approximately 0.028 ± 0.02 inch (0.07 ± 0.05 cm) yr^{-1} (Lemke et al., 2007).

In recent years (1993–2003), during which the observing system has been much better, thermal expansion and melting of land ice each account for about half of the observed sea level rise, although there is some uncertainty in the estimates. Thermal expansion contributed about 0.063 ± 0.02 inch (0.16 ± 0.05 cm) per year, reflecting a high rate of warming for the period relative to 1961 to 2003 (Bindoff et al., 2007). The total contribution from melting ice to sea level change between 1993 and 2003 ranged from 0.047 ± 0.016 inch (0.12 ± 0.04 cm) per year. The rate increased over the 1993 to 2003 period primarily due to increasing losses from mountain glaciers and ice caps, from increasing surface melt on the Greenland Ice Sheet, and from faster flow of parts of the Greenland and Antarctic Ice Sheets (Lemke et al., 2007).

Thermal expansion and exchanges of water between oceans and other reservoirs cause changes in the global mean as well as geographically non-uniform sea level change. Other factors influence changes at the regional scale, including changes in ocean circulation or atmospheric pressure, and geologic processes (Bindoff et al., 2007). Satellite measurements (for the period 1993–2003) provide unambiguous evidence of regional variability of sea level change (Bindoff et al., 2007). In some regions, rates of rise have been as much as several times the global mean, while sea level is falling in other regions. According to the IPCC (Bindoff et al., 2007), the largest sea level rise since 1992 has taken place in the western Pacific and eastern Indian oceans, while nearly all of the Atlantic Ocean shows sea level rise during the past decade with the rate of rise reaching a maximum (over 0.08 inch [0.2 cm] yr^{-1}) in a band running east-northeast from the U.S. east coast. Sea level in the eastern Pacific and western Indian oceans has been falling.

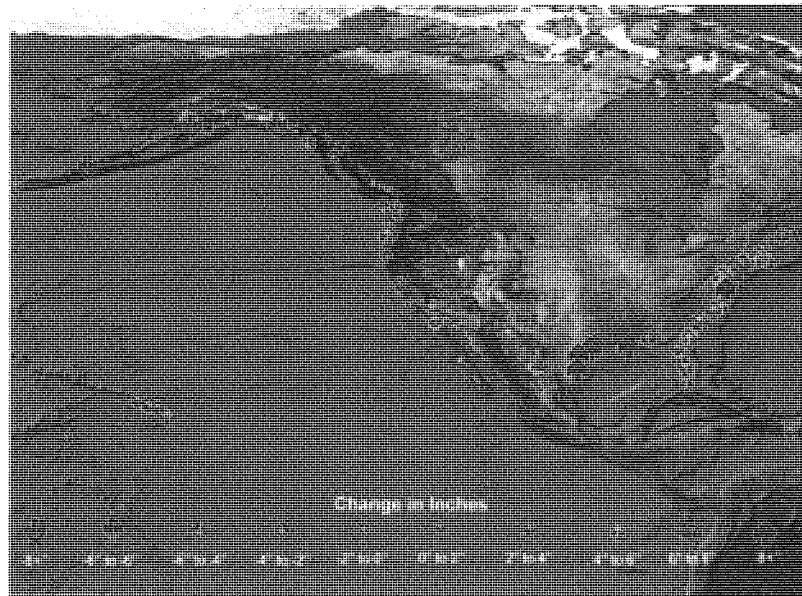
Ocean Heat Content

The thermal expansion of sea water is an indicator of increasing ocean heat content. Ocean heat content is also a critical variable for detecting the effects of the observed increase in GHGs in the Earth's atmosphere and for resolving the Earth's overall energy balance (Bindoff et al., 2007). For the period 1955 to 2005, Bindoff et al. (2007) analyze multiple time series of ocean heat content and find an overall increase, while noting interannual and inter-decadal variations. NOAA's report *State of the Climate in 2008* (Peterson and Baringer, 2009), which incorporates data through 2008, finds "large" increases in global ocean heat content since the 1950s and notes that over the last several years, ocean heat content has reached consistently higher values than for all prior times in the record.

4(g) U.S. Sea Level Rise

Sea level³⁷ has been rising 0.08 to 0.12 inch yr⁻¹ (0.2 to 0.3 cm yr⁻¹) along most of the U.S. Atlantic and Gulf coasts, as seen in Figure 4.6. During the past 50 years, sea level has risen up to 8 inches (20 cm) or more along some coastal areas, and has fallen in other locations (Karl et al., 2009). The rate of sea level rise varies from about 0.36 inch per year (1 cm yr⁻¹) along the Louisiana Coast (due to land sinking), to a drop of a few inches per decade in parts of Alaska (because land is rising). Records from the coast of California indicate that sea levels have risen almost 7.1 inches (18 cm) during the past century (California Energy Commission, 2006). According to the CCSP (2009b), in the Mid-Atlantic region from New York to North Carolina, tide-gauge observations indicate that relative sea level rise (the combination of global sea level rise and land subsidence) rates were higher than the global mean and generally ranged between 0.094 and 0.17 inch (0.24 and 0.44 cm) yr⁻¹, or about 1 inch (2.54 cm) over the 20th century.

Figure 4.6: Relative Sea Level Changes on United States Coastlines, 1958 to 2008.



Source: Karl et al. (2009) Observed changes in relative sea level from 1958 to 2008 for locations on the United States coast.

³⁷ U.S. sea level data obtained from the Permanent Service for Mean Sea Level (<http://www.pol.ac.uk/psmsl/>) of the the Proudman Oceanographic Laboratory.

Rosenzweig et al. (2007) document studies that find 75% of the shoreline, when the influence of spits, tidal inlets, and engineering structures is removed, is eroding along the U.S. East Coast probably due to sea level rise. They also cite studies reporting losses in coastal wetlands observed in Louisiana, the Mid-Atlantic region, and in parts of New England and New York, in spite of recent protective environmental regulations.

4(h) Global Ocean Acidification

Ocean waters can absorb large amounts of CO₂ from the atmosphere because when the gas dissolves in water it forms a weak acid, and the minerals dissolved in the ocean have created, over geologic time, a slightly alkaline ocean, with surface pH ranging from 7.9 to 8.25. The amount of carbon contained in the oceans has increased due to the elevated atmospheric pressure of CO₂ from anthropogenic emissions (Denman et al., 2007). The IPCC estimates that the total inorganic carbon content of the oceans increased by 118 ± 19 gigatonnes of carbon (GtC) between 1750 and 1994 and continues to increase (Bindoff et al., 2007). This absorptive capacity of the oceans has resulted in atmospheric CO₂ concentrations substantially lower than they otherwise would be. Since the beginning of the Industrial Revolution, global average sea surface pH has dropped by about 0.1 pH units, with the lowest decrease (0.06) in the tropics and subtropics, and the highest decrease (0.12) at high latitudes, consistent with the lower buffer capacity of the high latitudes compared to the low latitudes (Bindoff et al., 2007). This average pH decline of 0.1 pH unit corresponds to a 30% increase in the concentration of hydrogen ions (Denman et al., 2007).

Ocean acidification is causing a series of cascading changes to the chemistry of ocean water, including a decrease in the saturation state of calcium carbonate. Marine calcifiers, such as corals, are dependent upon this mineral to form shells, skeletons, and other protective structures. Reduced availability of calcium carbonate can slow or even halt calcification rates in these organisms (Fischlin et al., 2007). The availability of carbonate is also important because it controls the maximum amount of CO₂ that the ocean is able to absorb (Bindoff et al., 2007, p. 406). More information regarding ocean acidification projections and effects on marine ecosystems can be found in Sections 6(b) and 14(a), respectively. Ocean acidification is a direct consequence of fossil fuel CO₂ emissions, which are also the main driver of the anticipated climate change (Denman et al., 2007).

4(i) Global Changes in Physical and Biological Systems

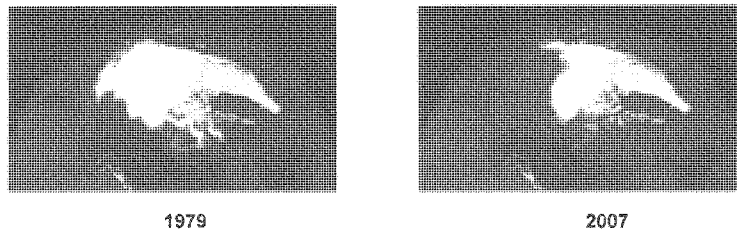
Physical and biological systems on all continents and in most oceans are already being affected by recent climate changes, particularly regional temperature increases (very high confidence) (Rosenzweig et al., 2007). Climatic effects on human systems, although more difficult to discern due to adaptation and non-climatic drivers, are emerging (medium confidence) (Rosenzweig et al., 2007). The majority of evidence comes from mid- and high latitudes in the Northern Hemisphere, while documentation of observed changes in tropical regions and the Southern Hemisphere is sparse (Rosenzweig et al., 2007). Hence, the findings presented in this section apply generally to the globe but most directly to Europe and North America (including the United States) where these observational studies were conducted. The extent to which observed changes discussed here can be attributed to anthropogenic GHG emissions is discussed in Section 5.

Cryosphere (Snow and Ice)

Observations of the cryosphere (the “frozen” component of the climate system) have revealed changes in sea ice, glaciers and snow cover, freezing and thawing, and permafrost. The following physical changes have been observed:

Ice cover in the Arctic began to diminish in the late 19th century, and this shrinkage has accelerated during the last several decades. Shrinkages that were both similarly large and rapid have not been documented over at least the last few thousand years, although the paleoclimatic record is sufficiently sparse that similar events might have been missed (Alley et al., 2009). Total annual Arctic sea ice extent has been declining at the rate of 4.1% (193,000 mi²; ~500,000 km²) per decade for the period 1979–2008 (NSIDC, 2009a). The latest data from NASA indicate Arctic sea ice set a record low in September 2007, 38% below the 1979–2007 average (NASA Goddard Space Flight Center, 2007). The extent of the sea ice loss between 1979 and 2007 can be seen in Figure 4.7. In September 2008, Arctic sea ice reached its second lowest extent on record (NASA Goddard Space Flight Center, 2008). In September 2009, Arctic sea ice reached its third lowest extent on record (NSIDC, 2009b).

Figure 4.7: Arctic Sea Ice Concentrations Comparisons



Source: NASA (2007), Sea Ice Yearly Minimum 1979-2007. Available at: <http://svs.gsfc.nasa.gov/vis/a000000/a003400/a003464/index.html>. These two images, constructed from satellite data, compare arctic sea ice concentrations in September of 1979 and 2007 (Images courtesy of NASA).

- For the period 1979–2008, Antarctic sea ice underwent a not statistically significant increase of 0.9% (~100,000 km²; 42,000 mi²) per decade (NSIDC, 2009a).
- The average sea ice thickness in the central Arctic has very likely decreased by up to 1 m from 1987 to 1997, based upon submarine-derived data. Model-based reconstructions support this finding, suggesting an Arctic-wide reduction of 24 to 35 inches (60 to 90 cm) over the same period (Lemke et al., 2007).
- Mountain glaciers and snow cover have declined on average in both hemispheres with evidence of acceleration in glacier decline in the last decade (Karl et al., 2009).
 - Though the studies cited by the IPCC (in Lemke et al., 2007) demonstrate widespread large-scale retreat of glacier tongues since the 1800s and mass losses since the 1960s (when mass loss measurements began), IPCC cautions records of directly measured glacier mass balances are few, and that there is high spatial and temporal variability in glacier trends. For example, it discusses glaciers along the coast of Norway and in the New Zealand Alps that advanced in the 1990s and started to shrink around 2000. It also notes that whereas glaciers in the high mountains of Asia have generally shrunk, several high glaciers in the central Karakoram are reported to have advanced and/or thickened at their tongues.
 - Northern hemisphere snow cover observed by satellite over the 1966–2005 period decreased in every month except November and December, with a stepwise drop of 5% in the annual mean in the late 1980s (Lemke et al., 2007). The NOAA-led *State of the Climate in 2008* report indicated the snow cover extent over the Northern Hemisphere in 2008 was 0.42 million square miles (1.1

million km²) less than the 39-year average, the fourth least extensive cover on record (Peterson and Baringer, 2009) In the Southern Hemisphere, the few long records or proxies mostly show either decreases or no changes in the past 40 years or more.

- The freeze-up date for river and lake ice has occurred later at a rate of 5.8 ± 1.6 days per century, averaged over available data for the Northern Hemisphere spanning the past 150 years. The breakup date has occurred earlier at a rate of 6.5 ± 1.2 days per century (Lemke et al., 2007).
- Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic (by up to 5°F [3°C]). The permafrost base has been thawing at a rate ranging up to 1.6 inches (4 cm) yr⁻¹ in Alaska since 1992 and 0.8 inch (2 cm) yr⁻¹ on the Tibetan Plateau since the 1960s. The maximum area covered by seasonally frozen ground has decreased by 7% in the Northern Hemisphere since 1900, with a decrease in spring of up to 15% (Lemke et al., 2007).

There are additional effects related to changes in the cryosphere. Melting of highly reflective snow and ice reveals darker land and ocean surfaces, creating a positive feedback that increases absorption of the sun's heat and further warms the planet. Increases in glacial melt and river runoff add more freshwater to the ocean, raising global sea level.

Hydrosphere

The term “hydrosphere” refers to the component of the climate system comprising liquid surface and subterranean water, such as rivers, lakes, and underground water. Several changes in these features have been observed, as summarized by the IPCC (Rosenzweig et al., 2007):

- Documented trends in severe droughts and heavy rains show that hydrological conditions are becoming more intense in some regions. Globally, very dry areas (Palmer Drought Severity Index—PDSI—less than or equal to -3.0) have more than doubled since the 1970s due to a combination of ENSO events and surface warming. Very wet areas (PDSI greater than or equal to +3.0) declined by about 5% since the 1970s, with precipitation as the major contributing factor during the early 1980s and temperature more important thereafter. The areas of increasing wetness include the Northern Hemisphere high latitudes and equatorial regions.
- Climate change signals related to increasing runoff and streamflow have been observed over the last century in many regions, particularly in basins fed by glaciers, permafrost, and snowmelt. Evidence includes increases in average runoff of Arctic rivers in Eurasia, which has been at least partly correlated with climate warming, and earlier spring snowmelt and increase in winter base flow in North America and Eurasia due to enhanced seasonal snow melt associated with climate warming.
- Freshwater lakes and rivers are experiencing increased water temperatures and changes in water chemistry. Surface and deep lake-waters are warming, with advances and lengthening of periods of thermal stability in some cases associated with physical and chemical changes such as increases in salinity and suspended solids, and a decrease in nutrient content. Lake formation and subsequent disappearance in permafrost have been reported in the Arctic.
- Changes in river discharge as well as in droughts and heavy rains in some regions indicate that hydrological conditions have become more intense but significant trends in floods and in evaporation and evapotranspiration have not been detected globally. Some local trends in reduced ground water and lake levels have been reported, but studies have been unable to separate the effects of variations

in temperature and precipitation from the effects of human interventions such as ground water management (Rosenzweig et al., 2007).

Biosphere

According to the IPCC, terrestrial ecosystems and marine and freshwater systems show that recent warming is strongly affecting natural biological systems (very high confidence) (Rosenzweig et al., 2007):

- The overwhelming majority of studies of regional climate effects on terrestrial species reveal consistent responses to warming trends, including poleward and elevational range shifts of flora and fauna. Changes in abundance of certain species, including limited evidence of a few local disappearances, and changes in community composition over the last few decades have been attributed to climate change.
- Responses of terrestrial species to warming across the Northern Hemisphere are well documented by changes in the timing of growth stages, especially the earlier onset of spring events, migration, and lengthening of the growing season. Changes in phenology (the timing of annual phenomena of animal and plant life) include clear temperature-driven extension of the growing season by up to two weeks in the second half of the 20th century in mid- and high northern latitudes, mainly due to an earlier spring, but partly due also to a later autumn. Egg-laying dates have advanced in many bird species, and many small mammals have been found to come out of hibernation and to breed earlier in the spring now than they did a few decades ago.
- Many observed changes in phenology and distribution of marine species have been associated with rising water temperatures, as well as other climate-driven changes in salinity, oxygen levels, and circulation. For example, plankton has moved poleward by 10° latitude over a period of four decades in the North Atlantic. While there is increasing evidence for climate change impacts on coral reefs, discerning the impacts of climate-related stresses from other stresses (e.g., overfishing and pollution) is difficult. Warming of lakes and rivers is affecting abundance and productivity, community composition, phenology, distribution, and migration of freshwater species (high confidence).

4(j) U.S. Changes in Physical and Biological Systems

Many of the global changes in physical and biological systems mentioned in Section 4(i) broadly apply to the United States. Some U.S.-specific changes in these systems cited in the IPCC's *Fourth Assessment Report* are described in this subsection, as well as in Section 11(a) for physical systems related to water resources and Section 14(a) related to biological systems. Of all the observed changes to physical systems assessed by the IPCC (Rosenzweig et al., 2007) for North America (totaling 355), 94% of them were consistent with changes one would expect with average warming. Similar consistency was found between observed biological system changes and warming for North America (see discussion below under *Biosphere*).

Furthermore, a CCSP (2008e) assessment reported that climate changes are very likely already affecting U.S. water resources, agriculture, land resources, and biodiversity as a result of climate variability and change. It noted that "[t]he number and frequency of forest fires and insect outbreaks are increasing in the interior West, the Southwest, and Alaska. Precipitation, streamflow, and stream temperatures are increasing in most of the continental United States. The western United States is experiencing reduced snowpack and earlier peaks in spring runoff. The growth of many crops and weeds is being stimulated. Migration of plant and animal species is changing the composition and structure of arid, polar, aquatic, coastal, and other ecosystems" (Backlund et al., 2008a)

Additional findings from this CCSP assessment along with results presented in IPCC's *Fourth Assessment Report* are described in the following sections.

Cryosphere (Snow and Ice)

In North America, from 1915 to 2004, snow-covered area increased in November, December, and January due to increases in precipitation. However, snow cover decreased during the latter half of the 20th century, especially during the spring over western North America (Lemke et al., 2007). Eight-day shifts towards earlier melt since the mid-1960s were also observed in northern Alaska (Lemke et al., 2007). Consistent with these findings, Lettenmaier et al. (2008) note a trend toward reduced mountain snowpack, and earlier spring snowmelt runoff peaks across much of the western United States.

The IPCC (Lemke et al., 2007) cites a study documenting glacier mass balance loss in the northwest United States and Alaska, with losses especially rapid in Alaska after the mid-1990s. Rosenzweig et al. (2007) refer to a study documenting evidence of present crustal uplift in response to recent glacier melting in Alaska.

Hydrosphere

Lettenmaier et al. (2008) document increases in U.S. streamflow during the second half of the 20th century consistent with increases in precipitation described in Section 4(e).

Rosenzweig et al. (2007) indicate surface water temperatures have warmed by 0.4 to 4°F (0.2 to 2°C) in lakes and rivers in North America since the 1960s. They also discuss evidence for an earlier occurrence of spring peak river flows and an increase in winter base flow in basins with important seasonal snow cover in North America.

Biosphere

The IPCC (Rosenzweig et al., 2007) assessed a multitude of studies that find changes in terrestrial ecosystems and marine and freshwater systems in North America. Of 455 biological observations assessed from these studies, 92% were consistent with the changes expected due to average warming.

Backlund et al. (2008a) find:

- There has been a significant lengthening of the growing season and increase in net primary productivity (NPP) in the higher latitudes of North America. Over the last 19 years, global satellite data indicate an earlier onset of spring across the temperate latitudes by 10 to 14 days.
- In an analysis of 866 peer-reviewed papers exploring the ecological consequences of climate change, nearly 60% of the 1,598 species studied exhibited shifts in their distributions and/or phenologies over the 20- and 140-year timeframe.
- Subtropical and tropical corals in shallow waters have already suffered major bleaching events that are clearly driven by increases in sea surface temperatures.

In addition, Ryan et al. (2008) note that "[c]limate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska."

4(k) Global Extreme Events

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of extreme events. The IPCC documents observed changes in climate extremes related to temperature, precipitation, tropical cyclones, and sea level. The changes described apply generally to all parts of the globe, including the United States, although there are some regional and local exceptions due to patterns of natural climate variability. Current observations are summarized here, projected trends are covered in Section 6, and the sectoral impacts of these changes are covered as relevant in Sections 7 to 15.

Temperature

Widespread changes in extreme temperatures have been observed in the last 50 years. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent (IPCC, 2007d). A widespread reduction in the number of frost days in mid-latitude regions, an increase in the number of warm extremes and a reduction in the number of daily cold extremes are observed in 70 to 75% of the land regions where data are available. The most marked changes are for cold nights (lowest 10%, based on 1961–1990), which have become rarer over the 1951–2003 period. Warm nights (highest 10%) have become more frequent.

Heavy Precipitation and Drought

Trenberth et al. (2007) note the following observed changes in drought and heavy precipitation events across the globe:

- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Increased drying linked with higher temperatures and decreased precipitation has contributed to changes in drought. The regions where droughts have occurred seem to be determined largely by changes in sea surface temperatures (SSTs), especially in the tropics, through associated changes in the atmospheric circulation and precipitation. Decreased snowpack and snow cover have also been linked to droughts.
- It is likely that there have been increases in the number of heavy precipitation events³⁸ within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate and observed significant increasing amounts of water vapor in the atmosphere. Increases have also been reported for rarer precipitation events (1-in-50-year return period), but only a few regions have sufficient data to assess such trends reliably (Trenberth et al., 2007).

Storms

Trenberth et al (2007) find there has *likely* been a net increase in frequency and intensity of strong low-pressure systems (also known as mid-latitude storms and/or extratropical cyclones) over Northern Hemisphere land areas, as well as a poleward shift in track since about 1950. They caution, however, that detection of long-term changes in cyclone measures is hampered by incomplete and changing observing systems. They also note longer records for the northeastern Atlantic suggest that the recent extreme period may be similar in level to that of the late 19th century.

³⁸ Heavy precipitation events refer to those in the 95th percentile of precipitation events.

The CCSP (2008i) report on extreme events, in its section on tropical cyclones (i.e., tropical storms and hurricanes), states that there have been spatially inhomogeneous increases in the power dissipation index, a measure of potential tropical cyclone destructiveness, over the last few decades (Kunkel et al., 2008). However, there remain reliability issues with historical data. Kunkel et al. (2008) refer to a study that was not able to corroborate the presence of upward intensity trends over the last two decades in ocean basins other than the North Atlantic. The report cautions that quantifying tropical cyclone variability is limited, sometimes seriously, by a large suite of problems with the historical record of tropical cyclone activity. Correspondingly, there is no clear trend in the annual numbers of tropical cyclones (IPCC, 2007d).

The IPCC (2007a; Trenberth et al., 2007) concluded there is insufficient evidence to determine whether trends exist in small-scale phenomena such as thunderstorms, tornadoes, hail, lightning and dust-storms.

High Sea Level

Apart from non-climatic events such as tsunamis, extreme sea levels occur mainly in the form of storm surges generated by tropical or extra-tropical cyclones. There is evidence for an increase in extreme high sea level since 1975 based upon an analysis of 99th percentiles of hourly sea level at 141 stations over the globe (Bindoff et al., 2007).

4(l) U.S. Extreme Events

Many of the global changes in extreme events mentioned in Section 4(k) broadly apply to the United States. Additionally, the U.S. CCSP (2008i) published a report that focused on changing climate extremes in the United States and North America. It concluded (Karl et al., 2008 in CCSP, 2008i):

Many extremes and their associated impacts are now changing. For example, in recent decades most of North America has been experiencing more unusually hot days and nights, fewer unusually cold days and nights, and fewer frost days. Heavy downpours have become more frequent and intense. Droughts are becoming more severe in some regions, though there are no clear trends for North America as a whole. The power and frequency of Atlantic hurricanes have increased substantially in recent decades, though North American mainland land-falling hurricanes do not appear to have increased over the past century. Outside the tropics, storm tracks are shifting northward and the strongest storms are becoming even stronger.

Many of these changes were also assessed in IPCC's *Fourth Assessment Report* and are described in this subsection.

Temperature

The IPCC (Trenberth et al., 2007) cites North America regional studies that all show patterns of changes in temperature extremes consistent with a general warming. Since 1950, the annual percent of days exceeding the 90th, 95th, and 97.5 percentile thresholds for both maximum (hottest daytime highs) and minimum (warmest nighttime lows) temperature have increased when averaged over all of North America (Kunkel et al., 2008). Karl et al. (2008) conclude the number of heat waves (extended periods of extremely hot weather) has been increasing over the past 50 years. This conclusion is based on the following findings in Kunkel et al. (2008):

- There was a highly statistically significant increase in the number of U.S. heat waves (defined as warm spells of 4 days in duration with mean temperature exceeding the threshold for a 1 in 10 year event) for the period 1960 to 2005

- The annual number of warm spells (defined as at least three consecutive days above the 90th percentile threshold done separately for maximum and minimum temperature) averaged over all of North America has increased since 1950.
- The heat waves of the 1930s remain the most severe in the U.S. historical record and suggest the intense drought of the period played a large role in the extreme heat by depleting soil moisture and reducing the moderating effects of evaporation.

Changes in cold extremes (days falling below the 10th, 5th, and 1st percentile threshold temperatures) show decreases, particularly since 1960 (Kunkel et al., 2008). Trenberth et al. (2007) cite a study finding intense warming of the lowest daily minimum temperatures over western and central North America. Trenberth et al. (2007) caution the observed changes of the tails of the temperature distributions are often more complicated than a simple shift of the entire distribution would suggest. Kunkel et al. (2008) find some evidence of a downward linear trend in cold waves (extended periods of cold) for the period 1895-2005, but note the trend is not statistically significant, largely owing to multi-decadal variability. But they find the very recent period from 1998-2007 exhibited fewer severe cold snaps than any other 10-year period in the historical record dating back to 1895. Kunkel et al. (2008) also indicate a decrease in frost days and a lengthening of the frost-free season over the past century.

Heavy Precipitation and Drought

In the contiguous United States, Trenberth et al. (2007) cite studies finding statistically significant increases in heavy precipitation (the heaviest 5%) and very heavy precipitation (the heaviest 1%) of 14 and 20%, respectively. The increase in the frequency and intensity of heavy downpours was responsible for most of the observed increase in overall precipitation (see Section 4e) during the last 50 years (Karl et al., 2009). Much of the increase in heavy precipitation occurred during the last three decades of the 20th century and is most apparent over the eastern parts of the country (Trenberth et al., 2007; Karl et al., 2009). There is also evidence from Europe and the United States that the relative increase in precipitation extremes is larger than the increase in mean precipitation (Trenberth et al., 2007). In fact, Karl et al. report there has been little change in the frequency of light and moderate precipitation during the past 30 years.

Lettenmaier et al. (2008) state that “[w]ith respect to drought, consistent with streamflow and precipitation observations, most of the continental United States experienced reductions in drought severity and duration over the 20th century. However, there is some indication of increased drought severity and duration in the western and southwestern United States....” For the past 50 years, Dole et al. (2008) conclude: “It is *unlikely* that a systematic change has occurred in either the frequency or area coverage of severe drought over the contiguous United States from the mid-twentieth century to the present.”

Diminishing snow pack and subsequent reductions in soil moisture appear to be factors in recent drought conditions in the western United States (Trenberth et al., 2007). This drought has also been attributed to changes in atmospheric circulation associated with warming of the western tropical Pacific and Indian oceans as well as multidecadal fluctuations (Trenberth et al., 2007).

Jansen et al. (2007) find (based on paleoclimate studies) that there have been periods over the past 2,000 years during which drought in North America was “more frequent, longer and/or geographically more extensive ... than during the 20th century.” They indicate some evidence suggests droughts were particularly extensive, severe, and frequent during intervals characterized by warmer than average summer temperatures in the Northern Hemisphere.

Storms

Karl et al. (2008) indicate a northward shift in the tracks of strong low-pressure systems (also known as mid-latitude storms and/or extratropical cyclones) in both the North Atlantic and North Pacific over the past fifty years with increases in storm intensity noted in the Pacific (data inconclusive in the Atlantic). Correspondingly, they also find northward shift in snow storm occurrence, which is also consistent with the warming temperatures and a decrease in snow cover extent over the United States.

Assessing trends in tropical cyclone (i.e., tropical storms and/or hurricanes) frequency and/or intensity is complicated by uncertainties in the observational record. Confidence in the tropical storm and hurricane record increases after 1900 and is greatest during the satellite era, from 1965 to present (Karl et al., 2009). IPCC (2007d) and Karl et al. (2009) report observational evidence of an increase in intense tropical cyclone activity in the North Atlantic (where cyclones develop that affect the U.S. East and Gulf Coasts) since about 1970, correlated with increases of tropical sea surface temperatures of nearly 2°F (1°C) in the main Atlantic hurricane development region (Karl et al., 2009). The strongest hurricanes (Category 4 and 5) have, in particular, increased in intensity (Karl et al., 2009).

The total number of Atlantic hurricanes and strongest hurricanes observed from 1881 through 2008 shows multi-decade periods of above-average activity in the 1800s, the mid-1900s, and since 1995 (Karl et al., 2009). During this period, there has been little change in the total number of land-falling hurricanes (Karl et al., 2009).

As in hurricanes, there are significant uncertainties in assessing long-term trends in thunderstorms and tornadoes due to changing observing systems. Kunkel et al. (2008) conclude: "There is no evidence for a change in the severity of tornadoes and severe thunderstorms, and the large changes in the overall number of reports make it impossible to detect if meteorological changes have occurred."

High Sea Level

Studies of the longest records of extremes in sea level are restricted to a small number of locations. Consistent with global changes, U.S.-based studies document increases in extreme sea level closely following the rise in mean sea level (Bindoff et al., 2007).

Section 5

Attribution of Observed Climate Change to Anthropogenic Greenhouse Gas Emissions at the Global and Continental Scale

This section addresses the extent to which observed climate change at the global and continental or national scale (described in Section 4) can be attributed to *global* anthropogenic emissions of GHGs. Section 2 describes the share of the U.S. transportation sector to U.S. and global anthropogenic emissions of GHGs, and the resultant share of U.S. transportation emissions to global increases in atmospheric concentrations of GHGs.

Evidence of the effect of anthropogenic GHG emissions on the climate system, as well as climate-sensitive systems and sectors, has increased over the last 15 years or so and even since the previous IPCC assessment published in 2001. The evidence in the recent IPCC *Fourth Assessment Report* (IPCC, 2007a) is based on analyses of global- and continental-scale temperature increases, changes in other climate variables and physical and biological systems, and the radiative forcing caused by anthropogenic versus natural factors.

5(a) Attribution of Observed Climate Change to Anthropogenic Emissions

The attribution of observed climate change to anthropogenic activities is based on multiple lines of evidence. The first line of evidence arises from the basic physical understanding of the effects of changing concentrations of GHGs, natural factors, and other human impacts on the climate system. The second line of evidence arises from indirect, historical estimates of past climate changes that suggest that the changes in global surface temperature over the last several decades are unusual (Karl et al., 2009). The third line of evidence arises from the use of computer-based climate models to simulate the likely patterns of response of the climate system to different forcing mechanisms (both natural and anthropogenic). Confidence in these models comes from their foundation in accepted physical principles and from their ability to reproduce observed features of current climate and past climate changes (IPCC, 2007a). For additional discussion on the strengths and limitations of models, see Section 6(b). Attribution studies evaluate whether observed changes are consistent with quantitative responses to different forcings (from GHGs, aerosols, and natural forcings such as changes solar intensity) represented in well-tested models and are not consistent with alternative physically plausible explanations.

Studies to detect climate change and attribute its causes using patterns of observed temperature change show clear evidence of human influences on the climate system (Karl et al., 2006). Discernible human influences extend to additional aspects of climate including ocean warming, continental-average temperatures, temperature extremes, and wind patterns (Hegerl et al., 2007).

Temperature

IPCC statements on the linkage between GHGs and temperatures have strengthened since the organization's early assessments (Solomon et al., 2007). The IPCC's *First Assessment Report* in 1990 contained little observational evidence of a detectable anthropogenic influence on climate (IPCC, 1990). In its *Second Assessment Report* in 1995, the IPCC stated the balance of evidence suggests a discernible human influence on the climate of the 20th century (IPCC, 1996). The *Third Assessment Report* in 2001 concluded that most of the observed warming over the last 50 years is likely to have been due to the increase in GHG concentrations (IPCC, 2001b). The conclusion in IPCC's 2007 *Fourth Assessment Report* (2007b) is the strongest yet:

Most of the observed increase in global average temperatures since the mid-20th century is very likely³⁹ due to the observed increase in anthropogenic GHG concentrations.

The IPCC (Hegerl et al., 2007) finds that anthropogenic GHG emissions were one of the influences contributing to temperature rise during the early part of the 20th century along with increasing solar output and a relative lack of volcanic activity. During the 1950s and 1960s, when temperature leveled off, increases in aerosols from fossil fuels and other sources are thought to have cooled the planet. For example, the eruption of Mt. Agung in 1963 put large quantities of reflective dust into the atmosphere. The rapid warming since the 1970s has occurred in a period when the increase in GHGs has dominated over all other factors (Hegerl et al., 2007).

The increased confidence in the GHG contribution to the observed warming results from (Hegerl, et al., 2007):

- An expanded and improved range of observations allowing attribution of warming to be more fully addressed jointly with other changes in the climate system.
- Improvements in the simulation of many aspects of present mean climate and its variability on seasonal to inter-decadal time scales.
- More detailed representations of processes related to aerosol and other forcings in models.
- Simulations of 20th-century climate change that use many more models and much more complete anthropogenic and natural forcings.
- Multi-model ensembles that increase confidence in attribution results by providing an improved representation of model uncertainty.

Box 5.1: The Relationship Between GHG Concentrations and Temperature Over Geologic Time and Implications for Attribution of Recent Global Temperature Trends

Direct and proxy measurements of past changes in biological, chemical, and physical indicators provide a means of reconstructing key aspects of past climates. These measurements show that past climates have been both warmer and colder than present, and that warmer periods have generally coincided with high atmospheric CO₂ levels (Jansen et al., 2007). While sources of uncertainty including inexact age models and possible seasonal biases remain a factor in paleoclimatic studies, recent methodological advances in, for example, multi-proxy approaches have led to increasingly confident reconstructions (Jansen et al., 2007).

Climate reconstructions reaching back in time beyond the reach of ice cores (i.e., prior to about one million years ago) are uncertain, but generally verify that warmer climates are to be expected with increased GHG concentrations (Jansen et al., 2007). Jansen et al. (2007) report that the major expansion of Antarctic glaciations starting around 35 to 40 million years ago (Ma) was likely a response, in part, to declining atmospheric CO₂ and that the major glaciations around 300 Ma likely coincided with low CO₂ concentrations relative to the surrounding periods. The mid-Pliocene (about 3.3 to 3.0 Ma) is the most recent time in Earth's history when global mean temperatures were substantially warmer than present for a prolonged period. Temperatures for mid-Pliocene are estimated by General Circulation Models (GCMs) to have been about 4 to 5°F (2 to 3°C) above pre-industrial levels (Jansen et al., 2007).

The ice core record extends for approximately 800,000 years and allows for higher-confidence assessments compared to the more distant past. According to the IPCC (Jansen et al., 2007), "The ice core record indicates that GHG co-varied with Antarctic temperature over glacial-interglacial time scales, suggesting a close link between natural atmospheric GHG concentrations and temperature." Evidence strongly suggests that the timing of glacial-interglacial periods are paced by the variations in the orbit of the earth; however, the large response of the climate system implies a strong positive amplification of the initial orbital forcing (Jansen et al., 2007). Jansen et al. (2007)

³⁹ According to IPCC terminology, "very likely" conveys a 90 to 99% probability of occurrence. See Box 1.2 for a full description of IPCC's uncertainty terms.

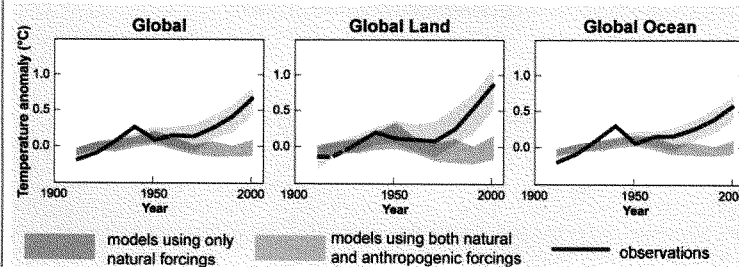
conclude: "It is *very likely* that glacial-interglacial CO₂ variations have strongly amplified climate variations, but it is *unlikely* that CO₂ variations have triggered the end of glacial periods. Antarctic temperatures started to rise several centuries before atmospheric CO₂ during past glacial terminations." CO₂ (and other GHG) changes over glacial to interglacial transitions, therefore, contribute to, but do not initiate, the temperature changes seen.

A variety of proxy records provide temporal and spatial information concerning climate change during the current interglacial, the Holocene, which began approximately 11.6 thousand years ago. Jansen et al. (2007) find evidence for local multi-centennial periods warmer than the last decades by up to several degrees in the early to mid-Holocene, but note that these local warm periods were very likely not globally synchronous and that the tendency for high-latitude summer temperature maxima to occur early in the Holocene (8,000-10,000 years ago) points to a direct influence of orbital forcing on temperature, rainfall, and sea ice extent. According to the IPCC (Jansen et al., 2007), current data limitations limit the ability to determine if there were multi-decadal periods of global warmth comparable to the last half of the 20th century prior to about 1,000 years ago.

The IPCC (Hegerl et al., 2007) reports that analyses of paleoclimate have increased confidence in the role of external influences on climate, and that key features of past climates have been reproduced by climate models using boundary conditions and radiative forcing for those periods.

Climate model simulations by the IPCC, shown in Figure 5.1, suggest natural forcings alone cannot explain the observed warming (for the globe, the global land and global ocean). The observed warming can only be reproduced with models that contain both natural and anthropogenic forcings.

Figure 5.1: Comparison of Observed Global-Scale Changes in Surface Temperature with Results Simulated by Climate Models Using Natural and Anthropogenic Forcings



Source: IPCC (2007d). Decadal averages of observations are shown for the period 1906 to 2005 (black line) plotted against the center of the decade and relative to the corresponding average for 1901 to 1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models to using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5–95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

Additional evidence documented in the IPCC report supports its statement linking warming to increasing concentrations of GHGs (Hegerl et al., 2007):

- Warming of the climate system has been detected in changes of surface and atmospheric temperatures, in the upper several hundred meters of the ocean (as evident by the observed increase in ocean heat content, see Section 4(f)), and in contributions to sea level rise. Attribution studies have established anthropogenic contributions to all of these changes.

- Analyses of paleoclimate data have increased confidence in the role of external influences on climate. Coupled climate models used to predict future climate have been used to reproduce key features of past climates using boundary conditions and radiative forcing for those periods.

The IPCC states that it is very unlikely that the global pattern of warming observed during the past half century is due to only known natural external causes (solar activity and volcanoes) since the warming occurred in both the atmosphere and ocean and took place when natural external forcing factors would likely have produced cooling (Hegerl et al., 2007). It also states GHG forcing alone would likely have resulted in warming greater than observed if there had not been an offsetting cooling effect from aerosols and natural forcings during the past half century (Hegerl et al., 2007). Solomon et al. (2007) and Karl et al. (2009) indicate the sum of solar and volcanic forcing in the past half century would likely have produced cooling, not warming.

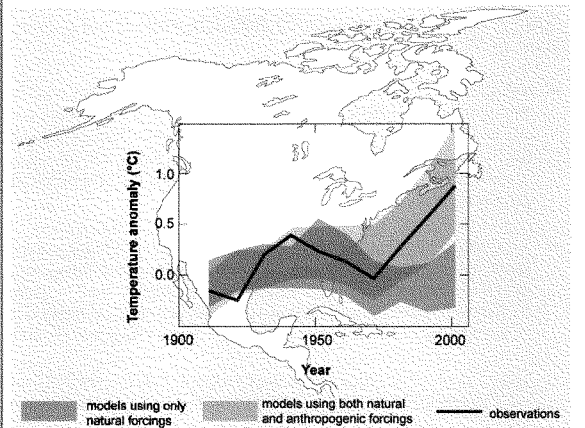
Not only has an anthropogenic signal been detected for the surface temperatures, but evidence has also accumulated of an anthropogenic influence through the vertical profile of the atmosphere. Fingerprint studies⁴⁰ have identified GHG and sulfate aerosol signals in observed surface temperature records, a stratospheric ozone depletion signal in stratospheric temperatures, and the combined effects of these forcing agents in the vertical structure of atmospheric temperature changes (Karl et al., 2006). Karl et al. (2009) state that more recent studies have also found human fingerprints in the patterns of change in Arctic and Antarctic temperatures. However, an important inconsistency may have been identified in the tropics. In the tropics, most observational data sets show more warming at the surface than in the troposphere, while almost all model simulations have larger warming aloft than at the surface (Karl et al., 2006). Karl et al. (2009) state that when uncertainties in models and observations are properly accounted for, newer observational data sets are in agreement with climate model results.

The IPCC states that the substantial anthropogenic contribution to surface temperature increases likely applies to every continent except Antarctica (which has insufficient observational coverage to make an assessment) since the middle of the 20th century (Hegerl et al., 2007). However, newer research led the USGCRP (Karl et al., 2009) to conclude that there are human fingerprints in the pattern of changes in Antarctic surface temperatures. Figure 5.2 indicates North America's observed temperatures over the last century can only be reproduced using model simulations containing both natural and anthropogenic forcings. In the CCSP (2008g) report *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change*, Dole et al. (2008) find that for North America "more than half of this warming [for the period 1951–2006] is likely the result of human-caused GHG forcing of climate change."

⁴⁰ Fingerprint studies use rigorous statistical methods to compare the patterns of observed temperature changes with model expectations and determine whether or not similarities could have occurred by chance. Linear trend comparisons are less powerful than fingerprint analyses for studying cause-effect relationships but can highlight important differences and similarities between models and observations (as in Figures 5.1 and 5.2).

Temperature extremes have also likely been influenced by anthropogenic forcing. Many indicators of climate extremes, including the annual numbers of frost days, warm and cold days, and warm and cold nights, show changes that are consistent with warming (Hegerl et al., 2007). An anthropogenic influence has been detected in some of these indices, and there is evidence that anthropogenic forcing may have substantially increased the risk of extremely warm summer conditions regionally, such as the 2003 European heat wave (Hegerl et al., 2007). Karl et al. (2008) conclude the increase in human-induced emissions of GHGs is estimated to have substantially increased the risk of a very hot year in the United States, such as that experienced in 2006. They add that other aspects of observed increases in temperature extremes, such as changes in warm nights and frost days, have been linked to human influences.

Figure 5.2: Comparison of Observed North American Changes in Surface Temperature with Results Simulated by Climate Models Using Natural and Anthropogenic Forcings



Source: Hegerl et al. (2007). Decadal averages of observations are shown for the period 1906 to 2005 (black line) plotted against the center of the decade and relative to the corresponding average for 1901 to 1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.

The IPCC (Hegerl et al., 2007) cautions that difficulties remain in attributing temperature changes on smaller than continental scales and over time scales of less than 50 years. It states that attribution at these scales, with limited exceptions, has not yet been established. It further explains (Hegerl et al., 2007):

Averaging over smaller regions reduces the natural variability less than does averaging over large regions, making it more difficult to distinguish between changes expected from different external forcings, or between external forcing and variability. In addition, temperature changes associated with some modes of variability are poorly simulated by models in some regions and seasons. Furthermore, the small-scale details of external forcing, and the response simulated by models are less credible than large-scale features.

Changes arising from internally generated variations in the climate system can influence surface and atmospheric temperatures substantially; however, climate models indicate that global-mean unforced variations on multidecadal timescales are likely to be smaller than the 20th century global-mean increase in surface temperature (Karl et al., 2006). The IPCC reports that global mean and hemispheric scale temperatures on multi-decadal time scales are largely controlled by external forcing (Hegerl et al., 2007).

Hegerl et al. (2007) note that “many observed changes in surface and free atmospheric temperature, ocean temperature, and sea ice extent, and some large-scale changes in the atmospheric circulation over the 20th century are distinct from internal variability and consistent with the expected response to anthropogenic forcing.”

Additional Climate Variables

There is evidence of anthropogenic influence in other parts of the climate system. The IPCC and CCSP noted the following examples:

- Anthropogenic forcing has *likely* contributed to the recent decreases in Arctic sea ice extent while noting large-scale modes of variability contribute to interannual variations in ice formation (Hegerl et al., 2007). Karl et al. (2009) also state year-to-year changes in sea ice extent are influenced by natural variations but add that the observed decline in Arctic sea ice has been more rapid than projected by climate models, and clear linkages between rising GHG concentrations and declines in Arctic sea ice have been identified.
- It is very likely that the response to anthropogenic forcing contributed to sea level rise during the latter half of the 20th century. Models including anthropogenic and natural forcing simulate the observed thermal expansion since 1961 reasonably well. Anthropogenic forcing dominates the surface temperature change simulated by models and has likely contributed to the observed warming of the upper ocean and widespread glacier retreat (Hegerl et al., 2007).
- Hegerl et al. (2007) find trends over recent decades in the Northern and Southern Annular Modes⁴¹, which correspond to sea level pressure reductions over the poles, are likely related in part to human activity, affecting storm tracks, winds, and temperature patterns in both hemispheres. Models reproduce the sign of the Northern Annular Mode trend, but the simulated response is smaller than observed. Models including both GHG and stratospheric ozone changes simulate a realistic trend in the Southern Annular Mode, leading to a detectable human influence on global sea level pressure patterns.
- According to the IPCC (Hegerl et al., 2007), a human influence has not been detected in global precipitation. However, the latitudinal pattern of change in land precipitation and observed increases in heavy precipitation over the 20th century appear to be consistent with the anticipated response to anthropogenic forcing. Karl et al. (2009) further state that increased extremes of summer dryness and winter wetness that have been observed are consistent with future projections of anthropogenic warming.

As with temperature, attributing changes in precipitation to anthropogenic forcing at continental or smaller scales is more challenging. One reason is that as spatial scales considered become smaller, the uncertainty becomes larger because internal climate variability is typically larger than the expected responses to forcing on these scales (Gutowski et al., 2008). For example, there is considerable evidence that modes of internal variability (such as ENSO, the Pacific Decadal Oscillation⁴², and NAM)

⁴¹ Annular modes are preferred patterns of change in atmospheric circulation corresponding to changes in the zonally averaged mid-latitude westerly winds. The Northern Annular Mode has a bias to the North Atlantic and has a large correlation with the North Atlantic Oscillation (see footnote 48). The Southern Annular Mode occurs in the Southern Hemisphere.

⁴² The Pacific Decadal Oscillation (PDO) is a pattern of Pacific climate variability that shifts phases on at least inter-decadal time scale, usually about 20 to 30 years. The PDO is detected as warm or cool surface waters in the Pacific

substantially affect the likelihood of extreme temperature, droughts, and short-term precipitation extremes over North America (Gutowski et al., 2008).

Karl et al. (2008) find that heavy precipitation events averaged over North America have increased over the past 50 years at a rate higher than total precipitation increased, consistent with the observed increases in atmospheric water vapor, which have been associated with human-induced increases in GHGs. Clark et al. (2008) state that recent drought in the Southwest is consistent with projections of increasing subtropical aridity and recent trends in increasing precipitation intensity are also consistent with projected trends. However, Clark et al. caution that there is considerable natural variability in the hydroclimate in the Southwest and conclude that: "There is no clear evidence to date of human-induced global climate change on North American precipitation amounts."

Regarding tropical cyclones (i.e., hurricanes and tropical storms), the IPCC (Hegerl et al., 2007) finds it is more likely than not that anthropogenic influence has contributed to increases in the frequency of the most intense storms. However, the IPCC (Hegerl et al., 2007) cautions that detection and attribution of observed changes in hurricane intensity or frequency due to external influences remains difficult because of deficiencies in theoretical understanding of tropical cyclones, their modeling, and their long-term monitoring. In the Atlantic basin, Gutowski et al. (2008, as cited in the CCSP, 2008i) likewise find evidence suggesting a human contribution to recent tropical cyclone activity in the Atlantic basin. Similar to IPCC, they caution that a confident assessment of human influence on hurricanes will require further studies using models and observations, with emphasis on distinguishing natural from human-induced changes in hurricane activity through their influence on factors such as historical sea surface temperatures, wind shear, and atmospheric vertical stability.

An anthropogenic influence has not yet been detected in extra-tropical cyclones owing to large internal variability and problems due to changes in observing systems (Hegerl et al., 2007).

5(b) Attribution of Observed Changes in Physical and Biological Systems

In addition to attributing the observed changes in average global- and continental-scale temperature and other climate variables to anthropogenic GHG forcing, a similar attribution can be made between anthropogenic GHG forcing and observed changes in physical systems (e.g., melting glaciers) and biological systems and species (e.g., geographic shift of species), which are shown to change as a result of recent warming.

This section includes the observed changes in physical and biological systems in North America and in other parts of the world.

The IPCC (2007b) concluded that "[o]bservational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases." Furthermore, the IPCC states that "[a] global assessment of data since 1970 has shown it is likely that anthropogenic warming has had a discernible influence on many physical and biological systems." As detailed in Section 5(a), recent warming of the last 50 years is very likely the result of the accumulation of anthropogenic GHGs in the atmosphere.

Climate variability and non-climate drivers (e.g., land-use change, habitat fragmentation) need to be considered in order to make robust conclusions about the role of anthropogenic climate change in affecting biological and physical systems. The IPCC (Rosenzweig et al., 2007) reviewed a number of

Ocean, north of 20° N. During a "warm", or "positive", phase, the west Pacific becomes cool and part of the eastern ocean warms; during a "cool" or "negative" phase, the opposite pattern occurs.

joint attribution studies that linked responses in some physical and biological systems directly to anthropogenic climate change using climate, process, and statistical models. The conclusion of these studies is that “the consistency of observed significant changes in physical and biological systems and observed significant warming across the globe likely cannot be explained entirely due to natural variability or other confounding non-climate factors (Rosenzweig et al., 2007).”

The physical systems undergoing significant change include the cryosphere (snow and ice systems), hydrological systems, water resources, coastal zones and the oceans. These effects (reported with high confidence by the IPCC (Rosenzweig et al., 2007) include ground instability in mountain and permafrost regions, a shorter travel season for vehicles over frozen roads in the Arctic, enlargement and increase of glacial lakes in mountain regions and destabilization of moraines damming these lakes, changes in Arctic flora and fauna including the sea-ice biomes and predators higher in the food chain, limitations on mountain sports in lower-elevation alpine areas, and changes in indigenous livelihoods in the Arctic.

Backlund et al. (2008a) specifically note: “There is a trend toward reduced mountain snowpack and earlier spring snowmelt runoff peaks across much of the western United States. This trend is very likely attributable at least in part to long-term warming, although some part may have been played by decadal-scale variability, including a shift in the phase of the Pacific Decadal Oscillation in the late 1970s.”

Regarding biological systems, the IPCC (Rosenzweig et al., 2007) reports with very high confidence that the overwhelming majority of studies of regional climate effects on terrestrial species reveal trends consistent with warming, including poleward and elevational range shifts of flora and fauna; the earlier onset of spring events, migration, and lengthening of the growing season; changes in abundance of certain species, including limited evidence of a few local disappearances; and changes in community composition.

Human system responses to climate change are more difficult to identify and isolate due to the larger role that non-climate factors play (e.g., management practices in agriculture and forestry, and adaptation responses to protect human health against adverse climatic conditions) (Rosenzweig et al., 2007).

Section 6

Projected Future Greenhouse Gas Concentrations and Climate Change

According to the IPCC (2007d), “continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely⁴³ be larger than those observed during the 20th century.” This section describes future GHG emissions scenarios, the associated changes in atmospheric concentrations and radiative forcing, and the resultant changes in temperature, precipitation and sea level at global and U.S. scales.

Scenarios are story lines regarding possible futures. These storylines are designed to be internally consistent in their assumptions regarding population and economic growth, implementation of policies, technology change and adoption, and other factors that will influence emissions. Scenarios are not predictions of the future but are used to illustrate how the future might look if a given set of events occurred and policies implemented. All future GHG emissions scenarios described in this section assume no new explicit GHG mitigation policies—neither in the United States nor in other countries—beyond those which were already enacted at the time the scenarios were developed. Future risks and impacts associated with the climate change projections are addressed in Part IV for domestic impacts and Part V for impacts in other regions of the world.

6(a) Global Emission Scenarios and Associated Changes in Concentrations and Radiative Forcing

Greenhouse Gas Emissions

As described in Section 4(a), a number of different GHGs and other factors, including aerosols, cause radiative forcing changes and thus contribute to climate change. This section discusses the range of published global reference (or baseline) future emission projections for which no explicit GHG mitigation policies beyond those currently enacted are assumed.

The IPCC’s most recent future climate change projections from the *Fourth Assessment Report* (IPCC, 2007a) (discussed in Section 6(b)) are based on the GHG emissions scenarios from the IPCC *Special Report on Emissions Scenarios (SRES)* (IPCC, 2000). Box 6.1 provides background information on the different SRES emissions scenarios. The SRES developed a range of long-term (to the year 2100) global reference scenarios for the major GHGs directly emitted by human activities and for some aerosols. The IPCC SRES scenarios do not explicitly account for implementation of the Kyoto Protocol. Figure 6.1 presents the global IPCC SRES projections for the two most significant anthropogenic GHGs: CO₂ emissions primarily from the burning of fossil fuels, and CH₄ emissions.

⁴³ According to IPCC terminology, “very likely” conveys a 90 to 99% probability of occurrence. See Box 1.2 for a full description of IPCC’s uncertainty terms.

Box 6.1: IPCC Reference Case Emission Scenarios from the Special Report on Emission Scenarios (SRES)

A1. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies).

A2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in a continuously increasing population. Economic development is primarily regionally oriented, and per capita economic growth and technological change is more fragmented and slower than other storylines.

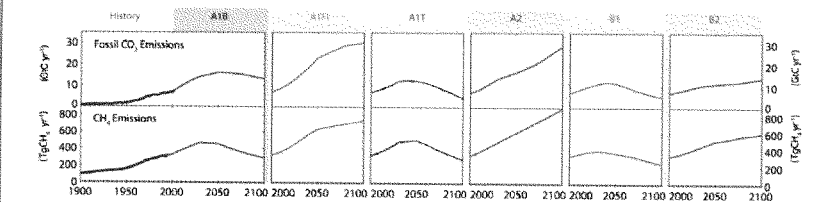
B1. The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

B2. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population (at a rate lower than A2), intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

An illustrative scenario was chosen for each of the six scenario groups—A1B, A1FI, A1T, A2, B1 and B2. All should be considered equally sound.

The SRES scenarios do not include additional climate initiatives, which means that no scenarios are included that explicitly assume implementation of the United Nations Framework Convention on Climate Change or the emission targets of the Kyoto Protocol.

Figure 6.1: Observed, and Projected Global CO₂ and CH₄ Emissions for the IPCC SRES Scenarios



Source: Meehl et al. (2007). Projected fossil CO₂ and CH₄ emissions for six illustrative SRES non-mitigation emissions scenarios. Historical emissions (black lines) are shown for fossil and industrial CO₂, and for CH₄.

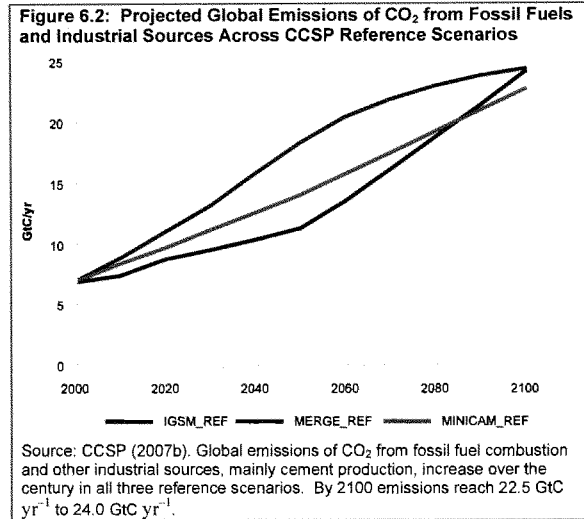
The main drivers of emissions are population, economic growth, technological change, and land-use activities including deforestation. The detailed underlying assumptions (including final and primary energy by major fuel types) across all scenarios, and across all modeling teams that produced the scenarios, can be found in IPCC (2000). The range of GHG emissions in the scenarios widen over time to reflect uncertainties in the underlying drivers. Similar future GHG emissions can result from different socio-economic developments. The IPCC (2000) SRES did not assign probabilities or likelihood to the scenarios, as it was stated that there is no single most likely, central, or best-guess scenario, either with respect to SRES scenarios or to the underlying scenario literature. This is why IPCC (2000) has recommended using a range of SRES scenarios with a variety of underlying assumptions for use in analysis.

Despite the range in future emissions scenarios, the majority of all reference-case scenarios project an increase of GHG emissions across the century and show that CO₂ remains the dominant GHG over the course of the 21st century. For 2030, projections of the six key GHGs (CO₂, CH₄, N₂O, HFCs, PFCs, SF₆) consistently show an increase of 25-90% compared with 2000, with more recent projections higher than earlier ones. Total *cumulative* (1990 to 2100) CO₂ emissions across the SRES scenarios range from 2,826 gigatonnes of CO₂ (GtCO₂) (or 770 GtC) to approximately 9,322 GtCO₂ (or 2,540 GtC) (IPCC, 2007c).⁴⁴

Since the IPCC SRES (2000), new scenarios have been published in the literature. The emissions scenario range from the recent literature is similar to the range in the IPCC SRES. The IPCC (2007c) reported that baseline annual emissions scenarios published since SRES are comparable in range to those presented in the SRES scenarios (25 to 135 GtCO₂eq per year in 2100). Studies since SRES used lower values for some drivers for emissions, notably population projections. However, for those studies incorporating these new population projections, changes in other drivers, such as economic growth, resulted in little change in overall emission levels (IPCC, 2007c).

For comparison, Figure 6.2 provides global projections of CO₂ emissions from the burning of fossil fuels and industrial sources from the three reference-case scenarios developed by the CCSP (CCSP, 2007b). Box 6.2 provides background information on the reference case scenarios developed by the CCSP. The CCSP scenarios, because they were developed more recently than the IPCC SRES scenarios, account for the implementation of the Kyoto Protocol for participating countries but no explicit GHG mitigation policies beyond the Kyoto Protocol. Emissions in 2100 are approximately 88 GtCO₂ (24 GtC). This level of emissions is above the post-SRES IPCC median of 60 GtCO₂ (16 GtC) but well within the 90th percentile of the IPCC range. The three reference scenarios developed by CCSP display a larger share of emissions growth outside of the Annex I nations.

⁴⁴ 1 gigatonne (Gt) = 1 billion metric tons.



Box 6.2: CCSP (2007b) Reference Case Emission Scenarios from Synthesis and Assessment Product 2.1

The scenarios in this report were developed using three integrated assessment models (IAMs). These models integrate socioeconomic and technological determinants of the emissions of GHGs with models of the natural science of earth system response, including the atmosphere, oceans, and terrestrial biosphere. The three IAMs used are:

- The Integrated Global Systems Model (IGSM) of the Massachusetts Institute of Technology's Joint Program on the Science and Policy of Global Change.
- The Model for Evaluating the Regional and Global Effects (MERGE) of GHG reduction policies developed jointly at Stanford University and the Electric Power Research Institute.
- The MiniCAM Model of the Joint Global Change Research Institute, a partnership between the Pacific Northwest National Laboratory and the University of Maryland. The MiniCAM model was also used to generate IPCC SRES scenarios.

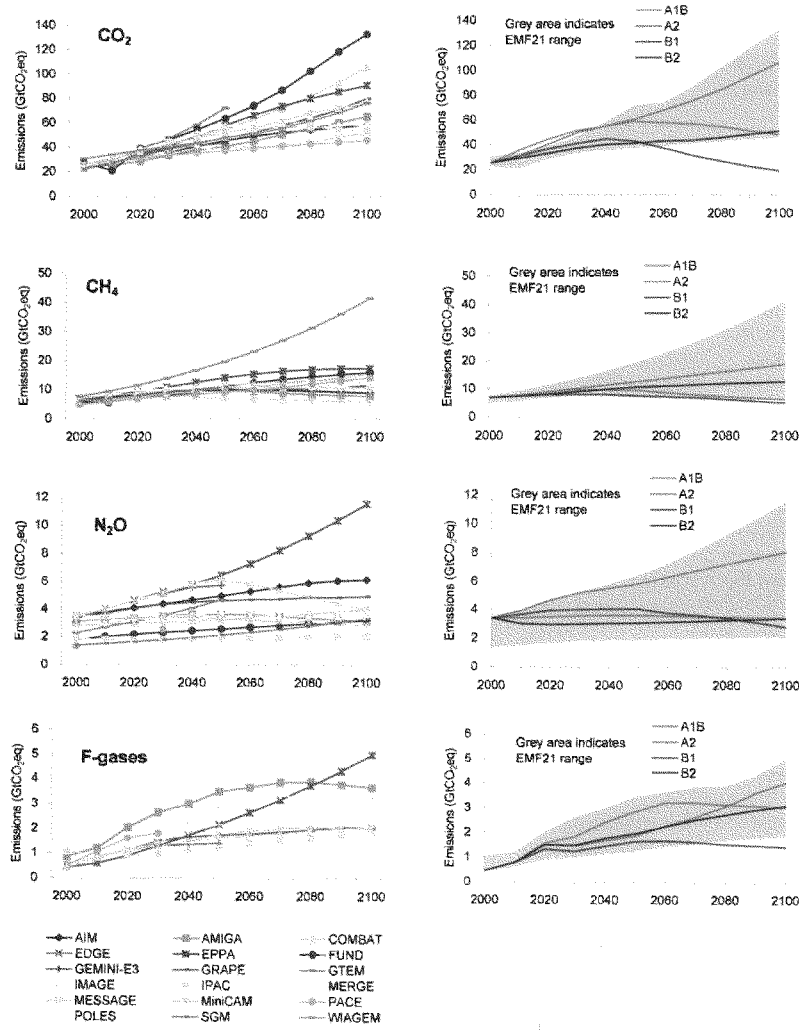
Each modeling group produced a reference scenario under the assumption that no climate policies are imposed beyond current commitments, namely the 2008-2012 first period of the Kyoto Protocol and the U.S. goal of reducing GHG emissions per unit of its gross domestic product by 18% by 2012. The resulting reference cases are not predictions or best-judgment forecasts, but scenarios designed to provide clearly defined points of departure for studying the implications of alternative stabilization goals. The modeling teams used model input assumptions they considered *meaningful and plausible*. The resulting scenarios provide insights into how the world might evolve without additional efforts to constrain GHG emissions, given various assumptions about principal drivers of these emissions, such as population increase, economic growth, land and labor productivity growth, technological options, and resource endowments.

Figure 6.3 illustrates reference case emission projections for CO₂, CH₄, N₂O, and the fluorinated gases in aggregate (HFCs, PFCs, and SF₆ or “F-gases”). The emission projections in Figure 6.3 are from the 21st Study of Stanford University’s Energy Modeling Forum (EMF) on multigas mitigation, as referenced by Fisher et al. (2007). Eighteen models participated in the EMF-21 study and the emission ranges in Figure 6.3 are representative of the literature. The broad ranges of EMF-21 emission projections in Figure 6.3, especially for N₂O and the fluorinated gases, illustrate the uncertainties in projecting these future emissions, which is generally consistent with the range found in SRES.

Emissions of ozone-depleting substances controlled under the Montreal Protocol (including CFCs and HCFCs) increased from a low level in 1970 to about 7.5 GtCO₂ in 1990, but then decreased to about 1.5 GtCO₂ in 2004, and are projected to decrease further due to the phase-out of CFCs in developing countries (IPCC, 2007c).

Modeling groups have developed a multiplicity of projections for the emissions of aerosol species. Within the IPCC process, all the SRES scenarios specified sulfate emissions. The inclusion, magnitude, and temporal evolution of other forcing agents such as nitrates and carbonaceous aerosols were left to the discretion of the individual modeling groups. There are still large uncertainties associated with current inventories of black carbon and organic carbon and the ad hoc scaling methods used to produce future emissions, and considerable variation among estimates of the optical properties of carbonaceous aerosols. Given these uncertainties, future projections of forcing by black carbon and organic carbon are quite dependent on the model and emissions assumptions (Meehl et al., 2007). Similarly, the CCSP (2008d) concluded that one of the most important uncertainties in characterizing the potential climate impact of aerosols is the projection of their future emissions.

Figure 6.3: EMF-21 and IPCC Global Emission Projections for CO₂, CH₄, N₂O, and the Fluorinated Gases



Source: CCSP (2007b). Development of baseline emissions in EMF-21 scenarios developed by a number of different modeling teams (left) and a comparison between EMF-21 and SRES scenarios (right).

For comparison, Figure 6.4 provides the global CH₄ and N₂O projections from the three CCSP reference-case scenarios (CCSP, 2007b).

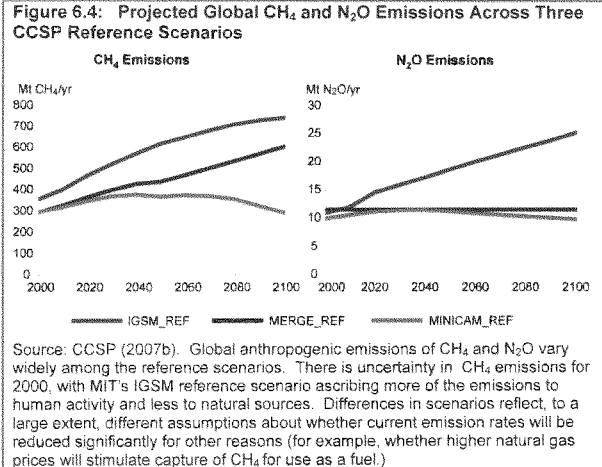
Future Concentration and Radiative Forcing Changes

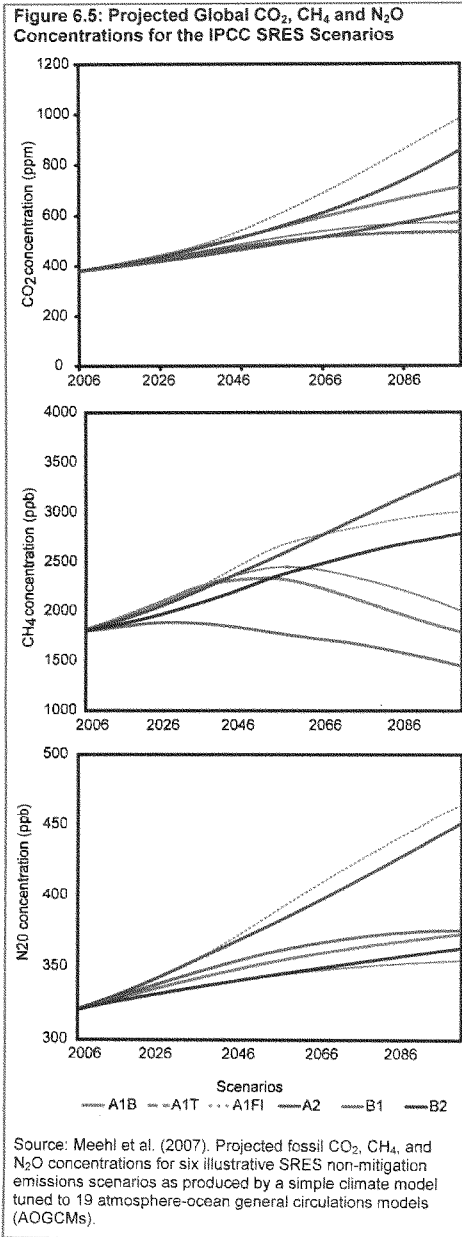
For a given emission scenario, various biogeochemical models are used to calculate concentrations of constituents in the atmosphere and various radiation schemes and parameterizations are required to convert these

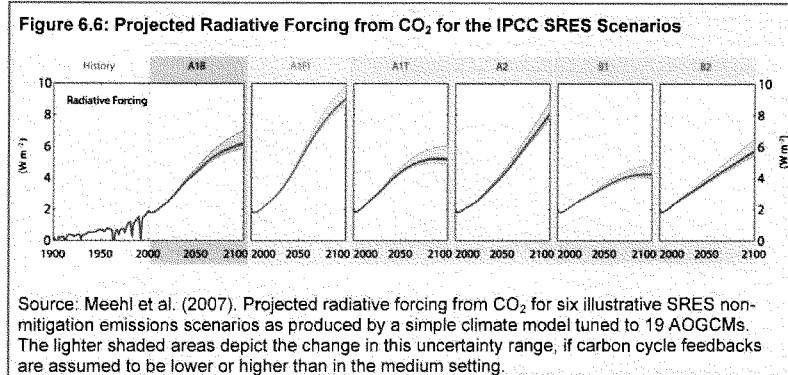
concentrations to radiative forcing. The formulation of, and interaction with, the carbon cycle in climate models also introduces important feedbacks. Uncertainty arises at each of these steps (Meehl et al. 2007). Historically, the airborne fraction of CO₂ (the increase of CO₂ concentrations relative to the emissions from fossil fuel and cement production) has shown no long term trend though it does vary from year to year mainly due to the effect of interannual variability in land uptake (Denman et al., 2007). However, for future projections, Meehl et al. (2007) found “unanimous agreement among the coupled climate carbon cycle models driven by emission scenarios run so far that future climate change would reduce the efficiency of the Earth system (land and ocean) to absorb anthropogenic CO₂. As a result, an increasingly large fraction of anthropogenic CO₂ would stay airborne in the atmosphere under a warmer climate.”

Figure 6.5 shows the latest IPCC projected increases in atmospheric CO₂, CH₄, and N₂O concentrations for the SRES scenarios, and Figure 6.6 shows the associated radiative forcing for these CO₂ scenarios. In general, reference concentrations of CO₂ and other GHGs are projected to increase. Concentrations of long-lived gases increase even for those scenarios where annual emissions toward the end of the century are assumed to be lower than current annual emissions. The CCSP scenarios show a similar picture of how atmospheric concentrations of the main GHGs and total radiative forcing change over time.

CO₂ is projected to be the largest contributor to total radiative forcing in all periods, and the radiative forcing associated with CO₂ is projected to be the fastest growing. The radiative forcing associated with the non-CO₂ GHGs is still significant and growing over time.







6(b) Projected Changes in Global Temperature, Precipitation Patterns, Sea Level Rise, and Ocean Acidification

Using the emissions scenarios described in Section 6(a), computer models project future changes in temperature, precipitation, and sea level at global and regional scales. According to the IPCC (Meehl et al., 2007):

“[C]onfidence in models comes from their physical basis, and their skill in representing observed climate and past climate changes. Models have proven to be extremely important tools for simulating and understanding climate, and there is considerable confidence that they are able to provide credible quantitative estimates of future climate change, particularly at larger scales. Models continue to have significant limitations, such as in their representation of clouds, which lead to uncertainties in the magnitude and timing, as well as regional details, of predicted climate change. Nevertheless, over several decades of model development, they have consistently provided a robust and unambiguous picture of significant climate warming in response to increasing greenhouse gases.”⁴⁵

Confidence decreases in changes projected by global models at smaller spatial scales. Many important small-scale processes cannot be represented explicitly in models and so must be included in approximate form as they interact with larger-scale features (Randall et al., 2007). Some of the most challenging aspects of understanding and projecting regional climate changes relate to possible changes in the circulation of the atmosphere and oceans, and their patterns of variability (Christensen et al., 2007). Nonetheless, the IPCC (2007d) concluded that recent advances in regional-scale modeling lead to higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation, and some aspects of extremes and of ice.

The CCSP (2008c) report *Climate Models: An Assessment of Strengths and Limitations* finds that models “have been steadily improving over the past several decades,” “show many consistent features in their simulations and projections for the future,” and “are able to simulate the recorded 20th century global mean temperature in a plausible way.” However, it cautions that projections of precipitation in some

⁴⁵ A number of climate models are developed and run at academic institutions and government-supported research laboratories in the United States and other countries. The IPCC helps coordinate modeling efforts to facilitate comparisons across models and synthesizes results published by several modeling teams.

cases remain “problematic” (especially at the regional scale) and that “uncertainties in the climatic effects of manmade aerosols (liquid and solid particles suspended in the atmosphere) constitute a major stumbling block” in certain modeling experiments. It adds that “uncertainties related to clouds increase the difficulty in simulating the climatic effects of aerosols, since these aerosols are known to interact with clouds and potentially can change cloud radiative properties and cloud cover.”

Global Temperature

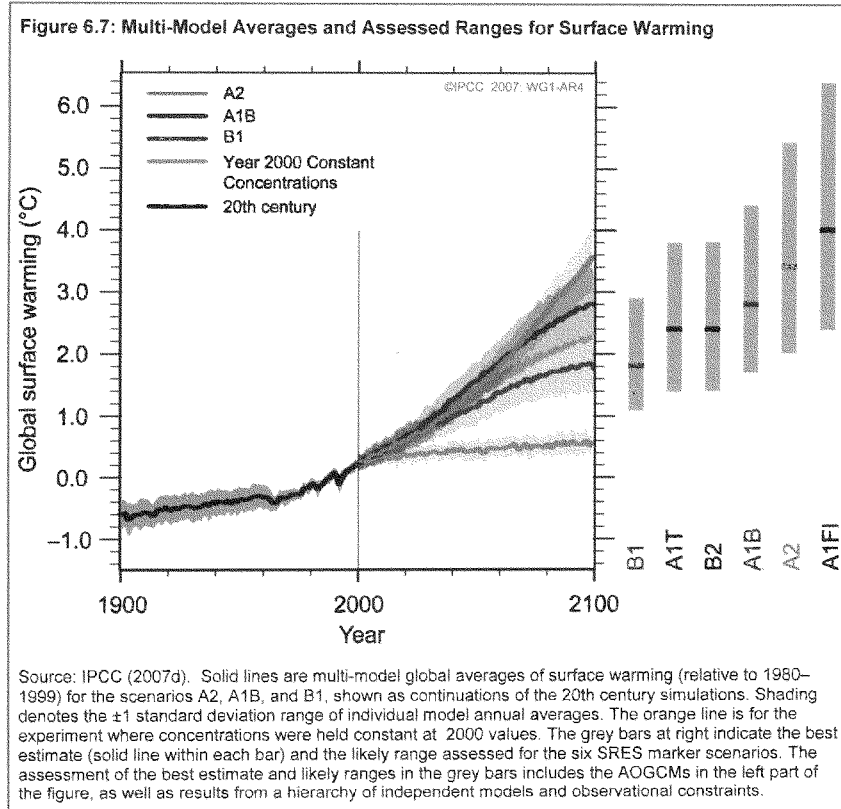
The latest IPCC assessment uses a larger number of simulations available from a broader range of models to project future climate relative to earlier assessments (IPCC, 2007d). All of the simulations performed by the IPCC project warming for the full range of emissions scenarios.

For the next two decades, a warming of about 0.4°F (0.2°C) per decade is projected for a range of SRES emissions scenarios (IPCC, 2007d). Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels (see the “Year 2000 Constant Concentrations” scenario in Figure 6.7), a further warming of about 0.2°F (0.1°C) per decade would be expected because of the time it takes for the climate system, particularly the oceans, to reach equilibrium (with year 2000 GHG levels). Through about 2030, the warming rate is mostly insensitive to choices between the SRES A2, A1B, or B1 scenarios and is consistent with that observed for the past few decades. Possible future variations in natural forcings (e.g., a large volcanic eruption) could change these values somewhat (Meehl et al., 2007). Large changes in emissions of short-lived gases could also have a near-term effect on temperatures, especially on the regional scale (CCSP, 2008d).

According to IPCC (see Figure 6.7), by mid-century (2046–2065), the choice of scenario becomes more important for the magnitude of the projected warming, with average values of 2.3°F (1.3°C), 3.2°F (1.8°C), and 3.1°F (1.7°C) from the models for scenarios B1 (low-emission growth), A1B (medium-emission growth) and A2 (high-emission growth), respectively (Meehl et al., 2007). About a third of that warming is projected to be due to climate change that is already committed (as shown in the “Year 2000 Constant Concentrations” scenario). By the 2090–2099 period (relative to the 1980–1999 range), projected warming varies significantly by emissions scenario. The full suite of SRES scenarios (given below) provides a warming range of 3.2°F to 7.2°F (1.8°C to 4.0°C) with an uncertainty range of 2.0°F to 11.5°F (1.1°C to 6.4°C). The multi-model average warming and associated uncertainty ranges for the 2090–2099 period (relative to 1980–1999) for each scenario, as illustrated in Figure 6.7 are shown in Table 6.1:

Scenario	Average Global Warming by End of Century Relative to ~1990	Uncertainty Range
B1	3.2°F (1.8°C)	2.0°F to 5.2°F (1.1°C to 2.9°C)
A1T	4.3°F (2.4°C)	2.5°F to 6.8°F (1.4°C to 3.8°C)
B2	4.3°F (2.4°C)	2.5°F to 6.8°F (1.4°C to 3.8°C)
A1B	5.0°F (2.8°C)	3.1°F to 7.9°F (1.7°C to 4.4°C)
A2	6.1°F (3.4°C)	3.6°F to 9.7°F (2.0°C to 5.4°C)
A1FI	+7.2°F (+4.0°C)	4.3°F to 11.5°F (2.4°C to 6.4°C)

The wide range of uncertainty in these estimates reflects the different assumptions about future concentrations of GHGs and aerosols in the various scenarios considered by the IPCC and the differing climate sensitivities of the various climate models used in the simulations (NRC, 2001a; Meehl et al., 2007; Karl et al., 2009).



Box 6.3: Climate Sensitivity

The sensitivity of the climate system to a forcing is commonly expressed in terms of the global mean temperature change that would be expected after a time sufficiently long enough for both the atmosphere and ocean to come to equilibrium with the change in climate forcing (NRC, 2001a). Since IPCC's Third Assessment Report (IPCC, 2001b), the levels of scientific understanding and confidence in quantitative estimates of equilibrium climate sensitivity have increased substantially (Meehl et al., 2007).

Solomon et al. (2007) indicate there is increased confidence of key processes that are important to climate sensitivity due to improved comparisons of models to one another and to observations. Water vapor changes dominate the feedbacks affecting climate sensitivity and are now better understood. Observational and model evidence support a combined water vapor-lapse rate (the rate at which air temperature decreases with altitude) feedback that corresponds to about a 50% amplification of global mean warming. Cloud feedbacks remain the largest source of uncertainty.

Basing their assessment on a combination of several independent lines of evidence, including observed climate change and the strength of known feedbacks simulated in general circulation models, the authors concluded that the global mean equilibrium warming for doubling CO₂ (a concentration of approximately 540 ppm), or "equilibrium climate sensitivity", very likely is greater than 2.7°F (1.5°C) and likely to lie in the range 4 to 8.1°F (2 to 4.5°C), with a most likely value of about 5°F (3°C). For fundamental physical reasons, as well as data limitations, the IPCC states a climate sensitivity higher than 8.1°F (4.5°C) cannot be ruled out, but that agreement for these values with observations and proxy data is generally worse compared to values in the 4 to 8.1°F (2 to 4.5°C) range (Meehl et al., 2007).

IPCC Climate Sensitivity Probabilities

Less than 2.7°F (1.5°C)	10% or less probability
Less than 3.6°F (2.0°C)	5-17% probability
4 to 8.1°F (2 to 4.5°C)	66-90% probability
Greater than 8.1°F (4.5°C)	5-17% probability

The overwhelming majority of the impacts literature assessed in IPCC analyzes the effects of warming for climate sensitivities within the most likely range (4 to 8.1°F [2 to 4.5°C]), not at the tails of the distribution. As such, the effects information summarized in Chapter IV, Sections 6-14 of this document focuses on the plausible climate change effects assessed for climate sensitivities within the most likely range. Section 5(d) does address the state of knowledge pertaining to low probability effects of climate change that may be triggered by abrupt (non-linear) processes that become more likely at higher rates of climate forcing (NRC, 2002). However, abrupt climate change processes cannot be predicted with confidence and the thresholds linked to risks for social systems are at least as uncertain (Schneider et al., 2007).

Geographical patterns of projected warming show greatest temperature increases over land (roughly twice the global average temperature increase) and at high northern latitudes, and less warming over the southern oceans and North Atlantic, consistent with observations (see Section 4b) during the latter part of the 20th century (Meehl et al., 2007).

According to the NOAA report *The State of the Climate in 2008* (Peterson and Baringer, 2009), the recent slowdown in observed climate warming (see Box 4.1) in some datasets has led some to question climate predictions of substantial 21st century warming. The study finds that climate models possess internal mechanisms of variability capable of reproducing the current slowdown in global temperature rise. It concludes that “[g]iven the likelihood that internal variability contributed to the slowing of global temperature rise in the last decade, we expect that warming will resume in the next few years, consistent with predictions from near-term climate forecasts.”

Global Precipitation

Models simulate that global mean precipitation increases with global warming (Meehl et al., 2007). However, there are substantial spatial and seasonal variations. Increases in the amount of precipitation are *very likely* in high latitudes, while decreases are *likely* in most subtropical land regions, continuing observed patterns in recent trends in observations. According to Solomon et al. (2007):

- In the Northern Hemisphere, a robust pattern of increased subpolar and decreased subtropical precipitation dominates the projected precipitation pattern for the 21st century over North America and Europe, while subtropical drying is less evident over Asia.
- In the Southern Hemisphere, there are few land areas in the zone of projected supolar moistening during the 21st century, with the subtropical drying more prominent.
- Projections of the precipitation over tropical land regions are more uncertain than those at higher latitudes.

Global Sea Level Rise

By the end of the century (2090–2099), sea level is projected by IPCC (2007d) to rise between 7.1 and 23 inches (18 and 59 cm) relative to the base period (1980–1999). These numbers represent the lowest and highest projections of the 5 to 95% ranges for all SRES scenarios considered collectively and include neither uncertainty in carbon cycle feedbacks nor rapid dynamical changes in ice sheet flow. In all scenarios, the average rate of sea level rise during the 21st century very likely exceeds the 1961 to 2003 average rate (0.071 to 0.02 inch [0.18 ± 0.05 cm] yr⁻¹). Even if GHG concentrations were to be stabilized, sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks (IPCC, 2007d). Thermal expansion of ocean water contributes 70 to 75% of the central estimate for the rise in sea level for all scenarios (Meehl et al., 2007). Glaciers, ice caps, and the Greenland Ice Sheet are also projected to add to sea level. The IPCC projects a range of sea level rise contributions from all glaciers, ice caps, and ice sheets between 2 to 9.1 inches (4 to 23 cm), not including the possibility of rapid dynamical changes. The Antarctic ice sheet is estimated to be a negative contributor to sea level rise over the next century under these assumptions (Meehl et al., 2007).

General circulation models indicate that the Antarctic ice sheet will receive increased snowfall without experiencing substantial surface melting, thus gaining mass and reducing sea level rise according to IPCC (Meehl et al., 2007). However, Meehl et al. (2007) note further accelerations in ice flow of the kind recently observed in some Greenland outlet glaciers and West Antarctic ice streams could substantially increase the contribution from the ice sheets, a possibility not reflected in the projections above. For example, if ice discharge from these processes were to increase in proportion to global average surface

temperature change, it would add 3.9 to 7.9 inches (10 to 20 cm) to the upper bound of sea level rise by 2090 to 2099. Dynamic processes related to ice flow not included in current models but suggested by recent observations could increase the vulnerability of the ice sheets to warming, increasing future sea level rise.

In the CCSP (2008a) report on abrupt climate change, Clark et al. (2008) find that “[r]ecent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning, with the velocity of some glaciers increasing more than twofold.” They add that “[i]nclusion of these processes in models will likely lead to sea level projections for the end of the 21st century that substantially exceed the projections presented in the IPCC AR4 [Fourth Assessment] report.”

The CCSP (2009b) sea level rise report notes that a recent study and other climate scientists have indicated that a global sea level rise of 39 inches (100 cm) is plausible within this century if increased melting of ice sheets in Greenland and Antarctica is added to the factors included in the IPCC estimates. It concludes: “Therefore, thoughtful precaution suggests that a global sea level rise of 39 inches (100 cm) to the year 2100 should be considered for future planning and policy discussions.” Though few studies have assessed the issue, Karl et al. (2009) report there is some evidence to suggest that it would be virtually impossible for the upper bound of sea level rise this century to exceed about 78 inches (198 cm).

The CCSP (2008c) report on the strengths and limitations of models notes that models of glacial ice are “in their infancy” and that “recent evidence for rapid variations in this glacial outflow indicates that more-realistic glacial models are needed to estimate the evolution of future sea level.”

Sea level rise during the 21st century is projected by IPCC to have substantial geographic variability due to factors that influence changes at the regional scale, including changes in ocean circulation or atmospheric pressure, and geologic processes (Meehl et al., 2007). The patterns in different models are not generally similar in detail, but have some common features, including smaller than average sea level rise in the Southern Ocean, larger than average sea level rise in the Arctic, and a narrow band of pronounced sea level rise stretching across the southern Atlantic and Indian oceans.

Global Ocean Acidification

The oceans have absorbed, and will continue to absorb, CO₂ emissions associated with anthropogenic activities. Surface ocean pH has decreased by 0.1 units due to oceanic absorption of CO₂, and it is predicted to decrease by an additional 0.3–0.4 units by 2100 (Fischlin et al., 2007). This projected rate of decline may lead to ocean pH levels within a few centuries that have not been observed for a few hundred million years (Denman et al., 2007). Acidification is affecting calcium carbonate saturation in ocean waters and is thereby reducing calcification rates of organisms that rely on the minerals for development. Future acidification is projected to result in under-saturated ocean waters (see Box 14.1 for information on the effects of this undersaturation). Polar and subpolar surface waters and the Southern Ocean will be aragonite (a form of calcium carbonate) undersaturated by 2100, and Arctic waters will be similarly threatened (Fischlin et al., 2007). According to a model experiment using a “business as usual” emissions scenario (IPCC -IS92a), biocalcification will be reduced by 2100, in particular within the Southern Ocean, and by 2050 for aragonite-producing organisms (Denman et al., 2007).

6(c) Projected Changes in U.S. Temperature, Precipitation Patterns, and Sea Level Rise

IPCC’s *Fourth Assessment Report* includes projections for changes in temperature, precipitation, and sea level rise for North America—which can be generalized for the United States—as well as some U.S.-specific information. These projections are summarized in this section.

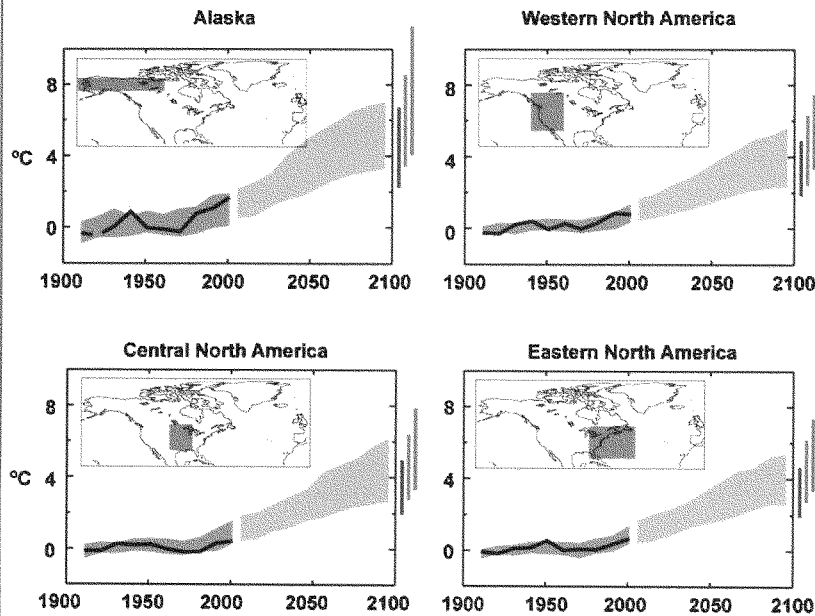
U.S. Temperatures

According to the IPCC, all of North America is very likely to warm during this century, as shown in Figures in 6.8 and 6.9, and warm more than the global mean warming in most areas (Christensen et al., 2007). For scenario A1B (moderate emission growth), the largest warming through 2100 is projected to occur in winter over northern parts of Alaska, reaching 13 to 18°F (7 to 10°C) in the northernmost parts, as shown in Figure 6.9, due to the positive feedback from a shorter season of snow cover. In western, central, and eastern regions of North America, the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans. The average warming in the United States through 2100 is projected by nearly all the models used in the IPCC assessment to exceed 4°F (2°C) for all scenarios (see Figure 6.8), with five out of 21 models projecting average warming in excess of 7°F (4°C) for the A1B (mid-range) emissions scenario.

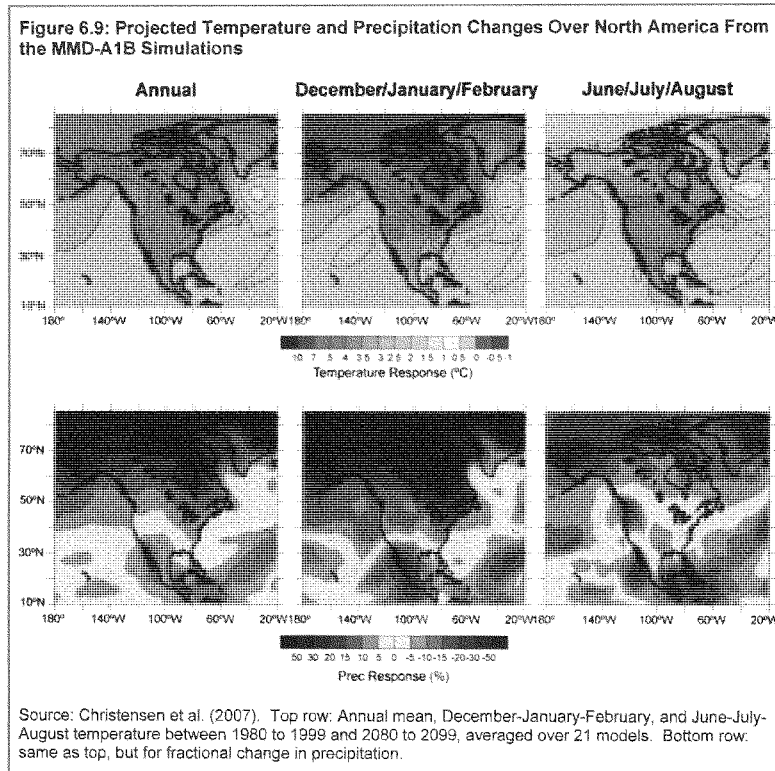
The CCSP (2008e) report *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity* provides shorter-term temperature projections for the United States for the year 2030. It projects a warming of approximately 2°F (1°C) in the southeastern United States, to more than 4°F (2°C) in Alaska and northern Canada, with other parts of North America having intermediate values (Backlund et al., 2008b).

By the end of the century, Karl et al. (2009) project average U.S. temperature to increase by approximately 7 to 11°F (4 to 6.1°C) under a high-emissions scenario (SRES A1FI) and by approximately 4 to 6.5°F (2 to 3.6°C) under a low-emissions scenario (SRES B1). On a seasonal basis, most of the United States is projected to experience greater warming in summer than in winter, while Alaska experiences far more warming in winter than summer (Karl et al., 2009).

Figure 6.8: Temperature Anomalies With Respect to 1901 to 1950 for Four North American Land Regions



Source: Christensen et al. (2007). Temperature anomalies with respect to 1901 to 1950 for four North American land regions (the "Alaska" region includes a portion of northwest Canada) for 1906 to 2005 (black line) and as simulated (red envelope) by multi-model dataset (MMD) models incorporating known forcings; and as projected for 2001 to 2100 by MMD models for the A1B scenario (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the B1 scenario (blue), the A1B scenario (orange), and the A2 scenario (red). The black line is dashed where observations are present for less than 50% of the area in the decade concerned.



U.S. Precipitation

A widespread increase in annual precipitation is projected by IPCC over most of the North American continent except the south and southwestern part of the United States and over Mexico, largely consistent with trends in recent decades (as described in Section 4) (Christensen et al., 2007). The largest increases are projected over northern North America (i.e., Canada and Alaska) associated with a poleward shift in storm tracks where precipitation increases by the largest amount in autumn and by the largest fraction in winter, as shown in Figure 6.9. In western North America, modest changes in annual mean precipitation are projected, but the majority of models indicate an increase in winter and a decrease in summer. Models show greater consensus on winter increases to the north and on summer decreases to the south. These decreases are consistent with enhanced subsidence and flow of drier air masses in the southwest United States and northern Mexico. Accordingly, some models project drying in the southwest United States, with more than 90% of the models projecting drying in northern and particularly western Mexico. On the windward slopes of the mountains in the West, precipitation increases are likely to be enhanced

due to orographic lifting⁴⁶. Overall, annual mean precipitation in the northeastern United States is very likely to increase and likely to decrease in the southwestern United States

Karl et al (2009) report model projections of future precipitation in the United States generally indicate northern areas will become wetter, and southern areas, particularly in the West, will become drier. In some northern areas, warmer conditions will result in more precipitation falling as rain and less as snow. In southern areas, significant reductions in precipitation are projected in winter and spring as the subtropical dry belt expands, particularly in the Southwest (Karl et al, 2009).

U.S. Sea Level Rise

For North American coasts, emissions scenario A1B shows sea level rise values close to the global mean, with slightly higher rates in eastern Canada and western Alaska, and stronger positive anomalies in the Arctic. The projected rate of sea level rise off the low-lying U.S. South Atlantic and Gulf coasts is also higher than the global average. Vertical land motion from geologic processes may decrease (uplift) or increase (subsidence) the relative sea level rise at any site (Nicholls et al., 2007).

Impact of Short-Lived Species on U.S. Temperature and Precipitation

Modeling results suggest that changes in short-lived species (mainly sulfates and black carbon) may significantly influence 21st century climate. A Geophysical Fluid Dynamics Laboratory (GFDL) simulation of SRES scenario A1B shows that changes in short-lived species could be responsible for up to 40% of the continental U.S. summertime warming projected to occur in this scenario by 2100 along with a statistically significant decrease in precipitation, mainly due to a combination of domestic sulfate emission reductions and increases in Asian black carbon emissions (CCSP, 2008d). However, the CCSP study concludes that “we could not find a consensus in this report on the duration, magnitude, or even sign (warming or cooling) of the climate change due to future levels of the short-lived gases and particles” due to uncertainties about different pollution control storylines.

6(d) Cryosphere (Snow And Ice) Projections, Focusing on North America and the United States

Snow season length and snow depth are very likely to decrease in most of North America as illustrated in Figure 6.10, except in the northernmost part of Canada where maximum snow depth is likely to increase (Christensen et al., 2007). Widespread increases in thaw depth are projected over most permafrost regions globally (IPCC, 2007d).

Lettenmaier et al. (2008) find where shifts to earlier snowmelt peaks and reduced summer and fall low flows have already been detected, continuing shifts in this direction are very likely.

Meehl et al (2007) conclude that as the climate warms, glaciers will lose mass, owing to dominance of summer melting over winter precipitation increases, contributing to sea level rise.

⁴⁶ Orographic lifting is defined as the ascent of air from a lower elevation to a higher elevation as it moves over rising terrain.

Sea ice is projected to shrink in both the Arctic and the Antarctic under all SRES scenarios. In some projections, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century (IPCC, 2007d). Taking into account recent late summer sea ice loss, Polyak et al (2009) indicate that the Arctic Ocean may become seasonally ice free as early as 2040.

6(e) Extreme Events, Focusing on North America and the United States

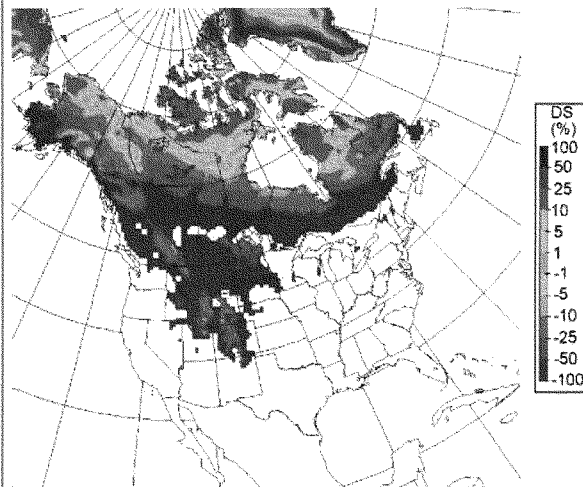
Models suggest that human-induced climate change is expected to alter the prevalence and severity of many extreme events such as heat waves, cold waves, storms, floods, and droughts. This section describes CCSP (2008i) and IPCC's projections for extreme events focusing on North America and the United States. Sections 7 to 14 summarize some of the sectoral impacts of extreme events for the United States.

Temperature

According to the IPCC, it is very likely that heat waves globally will become more intense, more frequent, and longer lasting in a future warm climate, whereas cold episodes are projected to decrease significantly. (Meehl, G.A. et al., 2007). Meehl et al. (2007) report on a study finding that the pattern of future changes in heat waves, with greatest intensity increases over western Europe, the Mediterranean, and the southeast and western United States, is related in part to circulation changes resulting from an increase in GHGs.

The IPCC cites a number of studies that project changes in temperature extremes in the United States (Christensen et al., 2007). One study finds that the frequency and the magnitude of extreme temperature events changes dramatically under a high-end emissions scenario (SRES A2), with increases in extreme hot events and decreases in extreme cold events. Another study examines changes in temperature extremes in their simulations centered on California and finds increases in extreme temperature events, prolonged hot spells, and increased diurnal temperature range. A third study finds increases in diurnal temperature range in six sub-regions of the western United States in summer.

Figure 6.10: Percent Snow Depth Changes in March



Source: Christensen et al. (2007). Percent snow depth changes in March (only calculated where climatological snow amounts exceed 5 mm of water equivalent), as projected by the Canadian Regional Climate Model (CCRM), driven by the Canadian General Circulation Model (CGCM), for 2041 to 2070 under SRES A2 compared to 1961 to 1990.

Karl et al. (2008) find for a mid-range scenario (A1B) of future GHG emissions, a day so hot that it is currently experienced only once every 20 years would occur every three years by the middle of the century over much of the continental United States; by the end of the century, it would occur every other year or more. The number of days exceeding 90°F (32°C) is projected to increase throughout the country with parts of the South that currently average 60 days per year with temperatures above 90°F (32°C) increasing to 150 or more such days by the end of the century under a high-emissions scenario (SRES A1FI) (Karl et al., 2009).

Some implications for human health resulting from these projected changes in temperature extremes are discussed in Section 7(b).

Heavy Precipitation and Drought

Intensity of precipitation events is projected to increase globally, particularly in tropical and high latitude areas that experience increases in mean precipitation (Meehl et al., 2007). Even in areas where mean precipitation decreases (most subtropical and mid-latitude regions), precipitation intensity is projected to increase but there would be longer periods between rainfall events. Meehl et al. (2007) note that increases in heavy precipitation events have been linked to increases in flooding.

The IPCC projects a tendency for drying in mid-continental areas during summer, indicating a greater risk of droughts in those regions (Meehl et al., 2007). Extreme drought increases from 1% of present-day land area to 30% by the end of the century in the A2 (high-emission growth) scenario according to a study assessed in Meehl et al. (2007). In the United States, Karl et al. (2009) conclude droughts are likely to become more frequent and severe in some regions, particularly the Southwest, as well as that the lightest precipitation is projected to decrease.

Several regional studies in the IPCC project changes in precipitation extremes in parts of the United States, ranging from a decrease in heavy precipitation in California to an increase during winter in the northern Rocky, Cascade, and Sierra Nevada mountain ranges (Christensen et al., 2007). For the contiguous United States, a study in Christensen et al. (2007) finds widespread increases in extreme precipitation events under SRES A2 (high-emission growth). Climate models consistently project that parts of the eastern United States will experience increased runoff, which accumulates as streamflow and can cause flooding when heavy precipitation persists for weeks to months in large river basins (Karl et al., 2009).

Karl et al. (2009) report that climate models project continued increases in the heaviest downpours during this century, and heavy downpours that are now one-in-20-year occurrences are projected to occur every four to 15 years by the end of this century, depending on location. The intensity of downpours is projected to increase by 10 to 25% by the end of the century relative to today (Karl et al., 2009).

Storms

The IPCC (Meehl et al., 2007) concludes model projections show fewer mid-latitude storms (or extra-tropical, primarily cold season) averaged over each hemisphere, associated with the poleward shift of the storm tracks that is particularly notable in the Southern Hemisphere, with lower central pressures for these poleward shifted storms. Over North America, Gutowski et al. (2008) indicate strong mid-latitude storms will be more frequent though the overall number of storms may decrease.

Based on a range of models, it is likely that tropical cyclones (tropical storms and hurricanes) will become more intense, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures (IPCC, 2007d). Karl et al. (2008) analyze model simulations and find

that for each 1.8°F (1°C) increase in tropical sea surface temperatures, core rainfall rates will increase by 6 to 18%, and the surface wind speeds of the strongest hurricanes will increase by about 1 to 8%. Storm surge levels are likely to increase because of increasing hurricane intensity coupled with sea level rise (Karl et al., 2009).

Karl et al. (2008) indicate projections in frequency changes in tropical cyclones are currently too uncertain for confident projections. Some modeling studies have projected a decrease in the number of tropical cyclones globally due to increased stability of the tropical atmosphere in a warmer climate, characterized by fewer weak storms and greater numbers of intense storms (Meehl et al., 2007). A number of modeling studies have also projected a general tendency for more intense but fewer storms outside the tropics, with a tendency towards more extreme wind events and higher ocean waves in several regions associated with these deepened cyclones (Meehl et al., 2007).

Sources of uncertainty involved with projecting changes in tropical cyclone activity include the limited capacity of climate models to adequately simulate intense tropical cyclones and potential changes in atmospheric stability and circulation (Karl et al., 2008). Taking these uncertainties into account, Karl et al. (2009) reached the following conclusion on the basis of both model- and theory-based evidence: "As ocean temperatures continue to increase in the future, it is likely that hurricane rainfall and wind speeds will increase in response to human-caused warming."

Possible implications of extreme precipitation events in the United States for health are described in Section 7, for food production and agriculture in Section 9, for water resources in Section 11, for coastal areas in Section 12, and for ecosystems and wildlife in Section 14.

6(f) Abrupt Climate Change and High-Impact Events

The CCSP (2008a), in its report on abrupt climate change, defines this phenomenon as a "large-scale change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades, and causes substantial disruptions in human and natural systems." Abrupt climate changes are an important consideration because, if triggered, they could occur so quickly and unexpectedly that human or natural systems would have difficulty adapting to them (NRC, 2002). Potential abrupt climate change implications in the United States are not discussed in Sections 7 through 14 (the U.S. sectoral impacts) because they cannot be predicted with confidence, particularly for specific regions. This section therefore focuses on the general risks of abrupt climate change globally, with some discussion of potential regional implications where information is available.

According to NRC (2002): "Technically, an abrupt climate change occurs when the climate system is forced to cross some threshold, triggering a transition to a new state at a rate determined by the climate system itself and faster than the cause." Crossing systemic thresholds may lead to large and widespread consequences (Schneider et al., 2007). The triggers for abrupt climate change can be forces that are external and/or internal to the climate system including (NRC, 2002):

- Changes in the Earth's orbit.⁴⁷
- A brightening or dimming of the sun.
- Melting or surging ice sheets.
- Strengthening or weakening of ocean currents.

⁴⁷ According to the National Research Council (2002), changes in the Earth's orbit occur too slowly to be prime movers of abrupt change but might determine the timing of events. Abrupt climate changes of the past were especially prominent when orbital processes were forcing the climate to change during the cooling into and warming out of ice ages (NRC, 2002).

- Emissions of climate-altering gases and particles into the atmosphere.

More than one of these triggers can operate simultaneously, since all components of the climate system are linked.

Scientific data show that abrupt changes in the climate at the regional scale have occurred throughout history and are characteristic of the Earth's climate system (NRC, 2002). During the last glacial period, abrupt regional warmings 14 to 30°F (8 to 16°C) within decades over Greenland) and coolings occurred repeatedly over the North Atlantic region (Jansen et al., 2007). These warmings likely had some large-scale effects such as major shifts in tropical rainfall patterns and redistribution of heat within the climate system, but it is unlikely that they were associated with large changes in global mean surface temperature.

NRC concluded that anthropogenic forcing may increase the risk of abrupt climate change (NRC, 2002):

"...greenhouse warming and other human alterations of the Earth system may increase the possibility of large, abrupt, and unwelcome regional or global climatic events. The abrupt changes of the past are not fully explained yet, and climate models typically underestimate the size, speed, and extent of those changes. Hence, future abrupt changes cannot be predicted with confidence, and climate surprises are to be expected."

Changes in weather patterns (sometimes referred to as weather regimes or natural modes) can result from abrupt changes that might occur spontaneously due to dynamic interactions in the atmosphere-ice-ocean system, or from the crossing of a threshold from slow external forcing (as described previously) (Meehl et al., 2007). In a warming climate, changes in the frequency and amplitudes of these patterns might not only evolve rapidly but also trigger other processes that lead to abrupt climate change (NRC, 2002). Examples of these patterns include ENSO and the North Atlantic Oscillation/Arctic Oscillation (NAO/OA).⁴⁸

ENSO has important linkages to patterns of tropical sea surface temperatures, which historically have been strongly tied to drought, including "megadroughts" that likely occurred between 900 and 1600 A.D. over large regions of the southwestern United States and Great Plains (Clark et al., 2008). The possibility of severe drought as an abrupt change resulting from changes in sea surface temperatures in a warming world is assessed by Clark et al. (2008). They find that under greenhouse warming scenarios, the cause of model-projected subtropical drying is an overall widespread warming of the ocean and atmosphere, in contrast to the causes of historic droughts (linked specifically to sea surface temperature). But they note models may not correctly represent the ENSO patterns of tropical SST change that could create impacts on global hydroclimate (e.g., drought) in addition to those caused by overall warming. The current model results do show drying over the southwestern United States, potentially increasing the likelihood of severe and persistent drought there in the future. Clark et al. (2008) note this drying has already begun (see also Section 4k) but caution that it is not clear if the present drying is outside the range of natural variability and linked to anthropogenic causes.

Scientists have investigated the possibility of an abrupt slowdown or shutdown of the Atlantic meridional overturning circulation (MOC) triggered by GHG forcing. The MOC transfers large quantities of heat to the North Atlantic and Europe, so an abrupt change in the MOC could have important implications for the

⁴⁸ The North Atlantic Oscillation (NAO) is the dominant mode of winter climate variability in the North Atlantic region ranging from central North America to Europe and much into Northern Asia. The NAO is a large-scale seesaw in atmospheric mass or pressure between the subtropical high and the polar low. Similarly, the Arctic Oscillation (AO) refers to opposing atmospheric pressure patterns in northern middle and high latitudes. The NAO and AO are different ways of describing the same phenomenon.

climate of this region (Meehl et al., 2007). However, according to Meehl et al. (2007), the probability of an abrupt change in (or shutdown of) the MOC is low: “It is very unlikely that the MOC will undergo a large abrupt transition during the 21st century. Even further into the future, Clark et al. (2008) note that “it is unlikely that the Atlantic MOC will collapse beyond the end of the 21st century because of global warming, although the possibility cannot be entirely excluded.” While models project a slowdown in the MOC over the 21st century and beyond, it is so gradual that the resulting decrease in heat transport to the North Atlantic and Europe would not be large enough to reverse the warming that results from the increase in GHGs (Clark et al., 2008). Clark et al. (2008) caution that while a collapse of the MOC is unlikely, the potential consequences of this event could be severe if it were to happen. Potential impacts include a southward shift of the tropical rainfall belts, additional sea level rise around the North Atlantic, and disruptions to marine ecosystems.

The rapid disintegration of the Greenland Ice Sheet (GIS), which would raise sea levels 23 feet (7 meters), is another commonly discussed abrupt change. Clark et al. (2008) report that observations demonstrate that it is extremely likely that the Greenland Ice Sheet is losing mass and that this loss has very likely been accelerating since the mid-1990s. In the CCSP (2009c) report *Past Climate Variability and Change in the Arctic and at High Latitudes*, Alley et al. (2009) find a threshold for ice-sheet removal from sustained summertime warming of 9°F (5°C), with a range of uncertainties from 3.6 to 12.6°F (2° to 7°C). Meehl et al. (2007), in the IPCC report, suggest the complete melting of the GIS would only require sustained warming in the range of 3.4 to 8.3°F (1.9°C to 4.6°C) (relative to the pre-industrial temperatures) but suggest it would take many hundreds of years to complete.

A collapse of the West Antarctic Ice Sheet (WAIS), which would raise seas 16 to 20 feet (5 to 6 meters), has been discussed as a low probability, high-impact response to global warming (NRC, 2002; Meehl et al., 2007). The weakening or collapse of ice shelves, caused by melting on the surface or by melting at the bottom by a warmer ocean, might contribute to a potential destabilization of the WAIS. Recent satellite and in situ observations of ice streams behind disintegrating ice shelves highlight some rapid reactions of ice sheet systems (Lemke et al., 2007). Clark et al. (2008) indicate that while ice is thickening over some higher elevation regions of Antarctica, substantial ice losses from West Antarctica and the Antarctic Peninsula are very likely occurring and that Antarctica is losing ice on the whole. Ice sheet models are only beginning to capture the small-scale dynamic processes that involve complicated interactions with the glacier bed and the ocean at the perimeter of the ice sheet (Meehl et al., 2007). These processes are not represented in the models used by the IPCC to project sea level rise. These models suggest Antarctica will gain mass due to increasing snowfall (although recent studies find no significant continent-wide trends in snow accumulation over the past several decades; Lemke et al., 2007), reducing sea level rise. But it is possible that acceleration of ice discharge could become dominant, causing a net positive contribution. Given these competing factors, there is presently no consensus on the long-term future of the WAIS or its contribution to sea level rise (Meehl et al., 2007).

Considering the Greenland and West Antarctic ice sheets together, Schneider et al. (2007) find paleoclimatic evidence suggests that Greenland and possibly the WAIS contributed to a sea level rise of 13 to 20 feet (4 to 6 meters) during the last interglacial, when polar temperatures were 5.4 to 9°F (3 to 5°C) warmer, and the global mean was not notably warmer than at present. Accordingly, they conclude with medium confidence that at least partial deglaciation of the Greenland Ice Sheet, and possibly the WAIS, would occur over a period of time ranging from centuries to millennia for a global average temperature increase of 2 to 7°F (1 to 4°C) (relative to 1990–2000), causing a contribution to sea level rise of 13 to 20 feet (4 to 6 meters) or more.

Another potential abrupt change of concern assessed by CCSP (2008a) is the catastrophic release of methane from clathrate hydrates in the sea floor and, to a lesser extent, in permafrost soils. Clark et al. (2008) find the following:

- The size of the hydrate reservoir is uncertain, perhaps by up to a factor of 10, making judgments about risk difficult to assess.
- Although there are a number of suggestions in the literature about the possibility of a dramatic abrupt release of methane to the atmosphere, modeling and isotopic fingerprinting of ice-core methane do not support such a release to the atmosphere over the last 100,000 years or in the near future.

Clark et al (2008) conclude:

“While the risk of catastrophic release of methane to the atmosphere in the next century appears very unlikely, it is very likely that climate change will accelerate the pace of persistent emissions from both hydrate sources and wetlands. Current models suggest that wetland emissions could double in the next century. However, since these models do not realistically represent all the processes thought to be relevant to future northern high-latitude CH₄ emissions, much larger (or smaller) increases cannot be discounted. Acceleration of persistent release from hydrate reservoirs is likely, but its magnitude is difficult to estimate.”

6(g) Effects on/from Stratospheric Ozone

Substances that deplete stratospheric ozone, which protects the Earth’s surface from much of the sun’s biologically harmful ultraviolet radiation, are regulated under Title VI of the Clean Air Act. According to the World Meteorological Organization (WMO, 2007), climate change that results from changing GHG concentrations will affect the evolution of the ozone layer through changes in chemical transport, atmospheric composition, and temperature. In turn, changes in the stratospheric ozone can have implications for the weather and climate of the troposphere. The coupled interactions between the changing climate and ozone layer are complex, and scientific understanding is incomplete (WMO, 2007). Specific information on climate change effects on/from stratospheric ozone in the United States has not been assessed. Except where indicated, the findings in this section apply generally to the globe, with a focus on polar regions.

Effects of Elevated Greenhouse Gas Concentrations on Stratospheric Ozone

WMO’s 2006 *Scientific Assessment of Ozone Depletion* (2007) concluded that future concentrations of stratospheric ozone are sensitive to future levels of the well-mixed GHGs. According to the WMO (2007):

- Future increases of GHG concentrations, primarily CO₂, will contribute to the average cooling in the stratosphere. Stratospheric cooling is expected to slow gas-phase ozone depletion reactions and increase ozone.
- Enhanced methane emission (from warmer and wetter soils) is expected to enhance ozone production in the lower stratosphere.
- An increase in nitrous oxide emissions is expected to reduce ozone in the middle and high stratosphere.

Two-dimensional models that include coupling between all of these well-mixed GHGs and temperature project that ozone levels between 60° S and 60° N will return to 1980 values up to 15 years earlier than in

models that are uncoupled (Bodeker et al., 2007). The impact of stratospheric cooling on ozone might be the opposite in polar regions where cooling could cause increases in polar stratospheric clouds, which, given enough halogens, would increase ozone loss (Bodeker et al., 2007).

Concentrations of stratospheric ozone are also sensitive to stratospheric water vapor concentrations which may remain relatively constant or increase (Baldwin et al., 2007). Increases in water vapor would cause increases in hydrogen oxide (HO_x) radicals, affecting ozone loss processes (Baldwin et al., 2007). Several studies cited in Baldwin et al. (2007) suggest increasing stratospheric water vapor would delay ozone layer recovery. Increases in stratospheric water vapor could also increase springtime ozone depletion in the polar regions by raising the temperature threshold for the formation of polar stratospheric clouds (WMO, 2007).

The possible effects of climate change on stratospheric ozone are further complicated by possible changes in climate dynamics. Climate change can affect temperatures, upper level winds, and storm patterns which, in turn, impact planetary waves⁴⁹ that affect the stratosphere (Baldwin et al., 2007). Changes in the forcing and propagation of planetary waves in the polar winter are a major source of uncertainty for predicting future levels of Arctic ozone loss (Baldwin et al., 2007).

The CCSP (2008h) report *Trends in Emissions of Ozone-Depleting Substances, Ozone Layer Recovery, and Implications for Ultraviolet Radiation Exposure* includes results from two-dimensional chemistry transport models and three-dimensional climate chemistry models estimating the recovery of the ozone layer under a GHG scenario. It finds:

- From 60°N to 60°S, global ozone is expected to return to its 1980 value up to 15 years earlier than the halogen recovery date because of stratospheric cooling and changes in circulation associated with GHG emissions. Global ozone abundances are expected to be 2% above the 1980 values by 2100 with values at mid-latitudes as much as 5% higher.
- Model simulations show that the ozone amount in the Antarctic will reach the 1980 values 10 to 20 years earlier (i.e., from 2040 to 2060) than the 2060 to 2070 timeframe of when the ozone-depleting substances reach their 1980 levels in polar regions.
- Most climate chemistry models show Arctic ozone values by 2050 to be larger than the 1980 values, with the recovery date between 2020 and 2040.

Climate Change Effects from Stratospheric Ozone

The WMO (2007) found changes to the temperature and circulation of the stratosphere affect climate and weather in the troposphere. The dominant tropospheric response, simulated in models and identified in analyses of observations, comprises changes in the strength of mid-latitude westerly winds. The mechanism for this response is not well-understood.

Modeling experiments (that simulate observed changes in stratospheric ozone and combined stratospheric ozone depletion and GHG increases) also suggest that Antarctic ozone depletion, through its effects on the lower stratospheric vortex, has contributed to the observed surface cooling over interior Antarctica and warming of the Antarctic Peninsula, particularly in summer (Baldwin et al., 2007). While the physics of these effects are not well-understood, the simulated pattern of warming and cooling is a robust result seen in many different models, and well-supported by observational studies.

⁴⁹ A planetary wave is a large horizontal atmospheric undulation that is associated with the polar-front jet stream and separates cold, polar air from warm, tropical air.

As the ozone layer recovers, tropospheric changes that have occurred as a result of ozone depletion are expected to reverse (Baldwin et al., 2007).

6(h) Land Use and Land Cover Change

Changes in land surface (vegetation, soils, water) resulting from human activities can significantly affect local climate through shifts in radiation, cloudiness, surface roughness, and surface temperature.

Solomon et al. (2007) find the impacts of land-use change on climate are expected to be locally significant in some regions, but are small at the global scale in comparison with greenhouse warming. Similarly, the release of heat from anthropogenic energy production can be significant over urban areas but is not significant globally (Solomon et al., 2007).

The CCSP report (2008e) on the effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States concludes that global climate change effects will be superimposed on and modify those resulting from land use and land cover patterns in ways that are as of yet uncertain.

Part IV

**U.S. Observed and Projected Human Health and Welfare Effects From
Climate Change**

Section 7

Human Health

Warm temperatures and extreme weather already cause and contribute to adverse human health outcomes through heat-related mortality and morbidity, storm-related fatalities and injuries, and disease. In the absence of effective adaptation, these effects are likely to increase with climate change. Depending on progress in health care and access, infrastructure, and technology, climate change could increase the risk of heat wave deaths, respiratory illness through exposure to aeroallergens and ozone (discussed in Section 8), and certain diseases (CCSP, 2008b; Confalonieri et al. 2007). Studies in temperate areas (which would include large portions of the United States) have shown that climate change is projected to bring some benefits, such as fewer deaths from cold exposure. The balance of positive and negative health impacts as a result of climate change will vary from one location to another and will alter over time as climate change continues (CCSP, 2008b).

In its *Third Assessment Report*, the IPCC produced a number of key findings summarizing the likely climate change health effects in North America. These effects, which were reaffirmed in the IPCC *Fourth Assessment Report* (Field et al., 2007), include:

- Increased deaths, injuries, infectious diseases, and stress-related disorders and other adverse effects associated with social disruption and migration from more frequent extreme weather.
- Increased frequency and severity of heat waves leading to more illness and death, particularly among the young, elderly, and frail.
- Expanded ranges of vector-borne and tick-borne diseases in North America but with moderating influence by public health measures and other factors.

The more recent CCSP (2008b) report on human health stated as one of its conclusions: “The United States is certainly capable of adapting to the collective impacts of climate change. However, there will still be certain individuals and locations where the adaptive capacity is less and these individuals and their communities will be disproportionately impacted by climate change.”

There are few studies that address the interactive effects of multiple climate change impacts or of interactions between climate change health impacts and other kinds of local, regional, and global socioeconomic changes (Field et al., 2007). For example, climate change impacts on human health in urban areas will be compounded by aging infrastructure, maladapted urban form and building stock, urban heat islands, air pollution, population growth, and an aging population (Field et al., 2007).

Vulnerability is the summation of all the factors of risk and resilience that determine whether individuals experience adverse health impacts. Specific subpopulations may experience heightened vulnerability for climate-related health effects. Climate change is very likely to accentuate the disparities already evident in the American health care systems, as many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured (Ebi et al., 2008).

The IPCC concludes that human health risks from climate change will be strongly modulated by changes in health care, infrastructure, technology, and accessibility to health care (Field et al., 2007). The aging of the population and patterns of immigration and/or emigration will also strongly influence risks (Field et al., 2007).

This section describes the literature on the impacts of climate change on human health in four areas: temperature effects, extreme events, climate sensitive diseases, and aeroallergens. The health impacts resulting from climate change effects on air quality are discussed in Section 8.

7(a) Temperature Effects

According to the IPCC (2007d), it is very likely⁵⁰ that there were warmer and fewer cold days and nights and warmer and more frequent hot days over most land areas during the late 20th century (see Section 4(b)). It is virtually certain that these trends will continue during the 21st century (see Section 6(b)). As a result of the projected warming, the IPCC projects increases in heat-related mortality and morbidity globally (IPCC, 2007b). The projected warming is also expected to result in fewer cold-related deaths. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality in the United States due to climate change (Gamble et al., 2008). Local factors, such as climate, topography, heat-island magnitude, demographic and health characteristics of the population, and policies that affect the social and economic structures of communities, including urban design, energy policy, water use and transportation planning are important in determining the underlying temperature-mortality relationship in a population (Confalonieri et al, 2007; Ebi et al., 2008).

Increased heat exposure

Extreme heat is associated with marked short-term increases in mortality (Confalonieri et al, 2007). Hot temperatures have also been associated with increased morbidity. A study cited in Field et al. (2007) indicates increased hospital admissions for cardiovascular disease and emergency room visits have been documented in parts of North America during heat events. The populations most vulnerable to hot temperatures are older adults, the chronically sick, the very young, city-dwellers, those taking medications that disrupt thermoregulation, the mentally ill, those lacking access to air conditioning, those working or playing outdoors, and the socially isolated (Ebi et al., 2008; IPCC, 2007b).

Exposure to heat is already the leading cause of weather-related deaths in the United States and more than 3,400 deaths between 1999 and 2003 were reported as resulting from exposure to extreme heat (Karl et al., 2009). The Centers for Disease Control and Prevention (CDC, 2006) indicate heat-related deaths can be difficult to identify when illness onset or death is not witnessed by a clinician and that the criteria used to determine heat-related causes of death vary among states. This can lead to underreporting of heat-related deaths or to reporting heat as a factor contributing to death rather than the underlying cause.

The excess mortality during the extreme heat wave in Europe in 2003 demonstrates the lethality of such events, which led to approximately 15,000 deaths in France alone (Confalonieri et al., 2007). Karl et al. (2009) report that an analysis of the European summer heat wave of 2003 found that the risk of such a heat wave is now roughly four times greater than it would have been in the absence of human-induced climate change.

Given projections for climate warming, heat-related morbidity and mortality are projected to increase globally (including in the United States) with climate warming (Confalonieri et al, 2007; Karl et al., 2009). Heat exposures vary widely, and current studies do not quantify the years of life lost due to high temperatures. Estimates of heat-related mortality attributable on extreme heat days are reduced but not eliminated when assumptions about acclimatization and adaptation are included in models. Confalonieri et al. (2007) cite a series of studies that suggests populations in the United States became less sensitive to high temperatures over the period 1964–1998, in part, due to these factors. However, Ebi et al. (2008)

⁵⁰ According to IPCC terminology, “very likely” conveys a 90 to 99% probability of occurrence. See Box 1.2 for a full description of IPCC’s uncertainty terms.

suggest these results do not imply future increases in heat-related mortality may not occur in the United States, because the percentage of the population with access to air conditioning is high in most regions (thus with limited possibilities for increasing access). In fact, Karl et al. (2009) note air-conditioning is reaching near saturation and report that a recent study shows that the general decline in heat-related deaths that had been observed since the 1970s leveled off in the mid-1990s.

Growing numbers of older adults will increase the size of the population at risk because of a decreased ability to thermoregulate that is a normal part of the aging process (Confalonieri et al, 2007). In addition, according to a study in Confalonieri et al. (2007), almost all the population growth in the next 50 years is expected to occur in cities where temperatures tend to be higher due to the urban heat island⁵¹ effect, increasing the total number of people at risk of adverse health outcomes from extreme heat conditions. In other words, non-climatic factors related to demographics will have a significant influence on future heat-related mortality.

Across North America, the population over the age of 65—those most at-risk of dying from heat waves—will increase slowly to 2010, and then grow dramatically as the Baby Boomers age (Field et al., 2007). Field et al. (2007) also find that severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur (high confidence). The IPCC documents the following U.S. regional scenario projections of increases in heat and/or heat-related effects (Confalonieri et al, 2007; Field et al., 2007):

- By the 2080s, in Los Angeles, the number of heat wave days (at or above 90°F [32 °C]) increases four-fold under the B1 emissions scenario (low growth) and six- to eight-fold under A1FI emissions scenario (high growth). Annual number of heat-related deaths in Los Angeles increases from about 165 in the 1990s to 319 to 1,182 for a range of emissions scenarios.
- Chicago is projected to experience 25% more frequent heat waves annually by the period spanning 2080–2099 for a business-as-usual (A1B) emissions scenario.

Additional projections for changes in extreme heat in the U.S. can be found in Section 15 on United States regional climate impacts.

Reduced Cold Exposure

Cold waves continue to pose health risks in northern latitudes in temperature regions where very low temperatures can be reached in a few hours and extend over long periods (Confalonieri et al, 2007). Accidental cold exposure occurs mainly outdoors, among socially deprived people (e.g., alcoholics, the homeless), workers, and the elderly in temperate and cold climates, but cold waves also affect health in warmer climates (Confalonieri et al, 2007). Living in cold environments in polar regions is associated with a range of chronic conditions in the non-indigenous population with acute risk from frostbite and hypothermia (Confalonieri et al, 2007). In countries with populations well-adapted to cold conditions, cold waves can still cause substantial increases in mortality if electricity or heating systems fail (Confalonieri et al, 2007).

Ebi et al. (2008) cite a study reporting that from 1979 to 2002, an average of 689 reported deaths per year (range 417 to 1,021) in the United States, totaling 16,555 over the period, were attributed to exposure to excessive cold temperatures on death certificates. The cold during these events also contributes to deaths caused by respiratory and cardiovascular diseases, so the overall mortality burden is likely underestimated (Ebi et al., 2008).

⁵¹ A heat island refers to urban air and surface temperatures that are higher than nearby rural areas. Many U.S. cities and suburbs have air temperatures up to 10°F (5.6°C) warmer than the surrounding natural land cover.

The IPCC projects reduced human mortality from cold exposure through 2100 (Confalonieri et al, 2007). Projections of cold-related deaths, and the potential for decreasing their numbers due to warmer winters, can be overestimated unless they take into account the effects of season and influenza, which is not strongly associated with monthly winter temperature (Ebi et al., 2008; Confalonieri et al, 2007). Ebi et al. (2008) report many factors contribute to winter mortality, making the question of how climate change could affect mortality highly uncertain. They report no projections have been published for the United States that incorporate critical factors such as the influence of influenza outbreaks.

Aggregated Changes in Heat and Cold Exposure

The IPCC (2007a) does not explicitly assess studies since the *Third Assessment Report*, which analyzes changes in *both* heat- and cold-related mortality in the United States in the observed climate or for different future climate scenarios. Given the paucity of recent literature on the subject and the challenges in estimating and projecting weather-related mortality, IPCC concludes additional research is needed to understand how the balance of heat- and cold-related deaths might change globally under different climate scenarios (Confalonieri et al, 2007). Similarly, Ebi et al. (2008) find net changes in mortality are difficult to estimate.

The most recent USGCRP assessment (Karl et al., 2009) refers to a study that analyzed daily mortality and weather data in 50 U.S. cities from 1989 to 2000 and found that, on average, cold snaps in the United States increased death rates by 1.6%, while heat waves triggered a 5.7% increase in death rates. The study concludes that increases in heat-related mortality due to global warming are unlikely to be compensated for by decreases in cold-related mortality.

7(b) Extreme Events

In addition to the direct effects of temperature on heat- and cold-related mortality, projected trends in climate change-related exposures of importance to human health will increase the number of people (globally, including in the United States) suffering from disease and injury due to floods, storms, droughts, and fires (high confidence) (Confalonieri et al, 2007). Vulnerability to weather disasters depends on the attributes of the people at risk (including where they live, age, income, education, and disability) and on broader social and environmental factors (level of disaster preparedness, health sector responses, and environmental degradation) (Ebi et al., 2008).

Floods and Storms

The IPCC projects a very likely increase in heavy precipitation event frequency over most areas as described in Section 6(b) and Section 6(c). Increases in the frequency of heavy precipitation events are associated with increased risk of deaths and injuries as well as infectious, respiratory and skin diseases (IPCC, 2007b). Floods are low-probability, high-impact events that can overwhelm physical infrastructure, human resilience, and social organization (Confalonieri et al, 2007). Flood health impacts include deaths, injuries, infectious diseases, intoxications, and mental health problems (Confalonieri et al, 2007). Karl et al. (2009) indicate flooding rains can increase incidence of waterborne diseases due to pathogens such as *Cryptosporidium* and *Giardia*. Flooding may also lead to contamination of waters with dangerous chemicals, heavy metals, or other hazardous substances from storage or from chemicals already in the environment (Confalonieri et al, 2007). In addition, heavy downpours can trigger sewage overflows, contaminating drinking water (Karl et al., 2009)

The IPCC (2007d) also projects likely increases in intense tropical cyclone activity as described in Section 6(b). Increases in tropical cyclone intensity are linked to increases in the risk of deaths, injuries,

waterborne and foodborne diseases, as well as post-traumatic stress disorders (IPCC, 2007b). Drowning by storm surge, heightened by rising sea levels and more intense storms (as projected by IPCC), is the major killer in coastal storms where there are large numbers of deaths (Confalonieri et al., 2007). High-density populations in low-lying coastal regions such as the U.S. Gulf of Mexico experience a high health burden from weather disasters, particularly among lower income groups. In 2005, Hurricane Katrina claimed more than 1,800 lives in the vicinity of the low-lying United States. Gulf Coast and lower income groups were disproportionately affected (Graumann et al., 2005; Nicholls et al., 2007; Confalonieri et al., 2007). While Katrina was a Category 3 hurricane, and its path was forecast well in advance, there was a secondary failure of the levee system. This illustrates that multiple factors contribute to making a disaster and that adaptation measures may not fully avert adverse consequences (Ebi et al., 2008). Additional information about U.S. vulnerability to the potential for more intense tropical cyclones can be found in Section 12(b).

Droughts

Areas affected by droughts are likely to increase according to the IPCC (2007d) as noted in Section 6(e). The health impacts associated with drought tend to most affect semi-arid and arid regions, poor areas and populations, and areas with human-induced water scarcity; hence, many of these effects are likely to be experienced in developing countries and not directly in the United States. Information about the effects of increasing drought on U.S. agriculture can be found in Section 9(c).

Wildfires

In some regions, changes in the mean and variability of temperature and precipitation are projected to increase the size and severity of fire events, including in parts of the United States (Easterling et al., 2007). Wildfires can increase eye and respiratory illnesses and injuries, including burns and smoke inhalation (Ebi et al., 2008). A study cited in Confalonieri et al. (2007) indicates large fires are also accompanied by an increased number of patients seeking emergency services for inhalation of smoke and ash. The IPCC (Field et al., 2007) noted a number of observed changes in U.S. wildfire size and frequency. Additional information on the effects of forest fires can be found in Sections 8(b) and 10(b).

7(c) Climate-Sensitive Diseases

The IPCC (2007b) notes that many human diseases are sensitive to weather. Similarly Karl et al. (2009) reports that important disease-causing agents commonly transmitted by food, water, or animals are susceptible to changes in replication, survival, persistence, habitat range, and transmission as a result of changing climatic conditions such as increasing temperature, precipitation, and extreme weather events. They conclude some diseases transmitted by food, water, and insects are likely to increase.

The incidence of airborne infectious diseases (e.g., coccidioidomycosis) varies seasonally and annually, due partly to climate variations such as drought, which is projected to increase in the southwestern United States (Field et al., 2007; Karl et al., 2008).

Waterborne disease outbreaks are distinctly seasonal (which suggests potential underlying environmental or weather control), clustered in particular watersheds, and associated with heavy precipitation. IPCC (Confalonieri et al., 2007) reports that the risk of infectious disease following flooding in high-income countries is generally low, although increases in respiratory and diarrheal diseases have been reported after floods. However, CCSP (Peterson et al., 2008) finds that analyses of the United States indicate that the assumption that developed countries have low vulnerability may be premature, citing to studies that “have repeatedly concluded that water and food-borne pathogens (that cause diarrhea) will likely increase with projected increases in regional flooding events, primarily by contamination of main waterways.” In

another report, CCSP (2008b) notes that flooding can overwhelm sanitation infrastructure and lead to water-related illnesses. A U.S. study documented that 51% of waterborne disease outbreaks were preceded by precipitation events in the top 10% of occurrences, with 68% of outbreaks preceded by precipitation in the top 20% (Peterson et al., 2008). After hurricanes Katrina and Rita in 2005, contamination of water supplies with fecal bacteria led to many cases of diarrheal illness and some deaths (Ebi et al., 2008; CDC, 2005; Confalonieri et al., 2007).

Foodborne diseases show some relationship with temperature (e.g., increased temperatures have been associated with increased cases of Salmonellosis) (Confalonieri et al., 2007). *Vibrio* spp. infections from shellfish consumption may also be influenced by temperature (Confalonieri et al., 2007). For example, Confalonieri et al. (2007) cited a study documenting a 2004 outbreak of *V. parahaemolyticus* linked to atypically high temperatures in Alaskan coastal waters.

According to the CCSP (2008b) report, for the U.S., it is not anticipated that climate change will lead to loss of life or years of life due to chronic illness or injury from waterborne or foodborne illnesses. However, it notes there will likely be an increase in the spread of several foodborne and waterborne pathogens among susceptible populations depending on the pathogens' survival, persistence, habitat range, and transmission under changing climate and environmental conditions. While the United States has successful programs to protect water quality under the Safe Drinking Water Act and the Clean Water Act, some contamination pathways and routes of exposure do not fall under regulatory programs (e.g., dermal absorption from floodwaters, swimming in lakes and ponds with elevated pathogen levels). The primary climate-related factors that affect these pathogens include temperature, precipitation, extreme weather events, and shifts in ecological regimes. Consistent with the latest understanding of climate change on human health, the impact of climate on foodborne and waterborne pathogens will seldom be the only factor determining the burden of human injuries, illness, and death (CCSP 2008b).

The sensitivity of many zoonotic⁵² diseases to climate fluctuations is also highlighted by the IPCC (Field et al., 2007). Saint Louis encephalitis has a tendency to appear during hot, dry La Nina years according to a study cited in Field et al. (2007). Associations between temperature and precipitation and tick-borne Lyme disease are also noted by IPCC (Field et al., 2007). A study cited in Field et al. (2007) found that the northern range limit of *Ixodes scapularis*, the tick that carries Lyme disease, could shift north by 120 mi (200 km) by the 2020s and 620 mi (1,000 km) by the 2080s. According to Ebi et al. (2008), studies suggest that higher minimum temperatures generally were favorable to the potential of expanding tick distributions and greater local abundance of these vectors. However, Ebi et al. (2008) add that: "changing patterns of tick-borne disease in Europe are not consistently related to changing climate (Randolph, 2004a). Climate change is projected to decrease the geographic range of TBE (tick-borne encephalitis) in areas of lower latitude and elevation as transmission expands northward (Randolph and Rogers, 2000)".

A study discussed in Field et al. (2007) linked above-average temperatures in the United States during the summers of 2002–2004 to the greatest transmissions of West Nile virus. Karl et al. (2009) refer to a study that suggests greater risks from West Nile virus may result from increases in the frequency of heatwaves, though the risk will also depend on the effectiveness of mosquito control programs.

Although large portions of the United States may be at potential risk for diseases such as malaria based on the distribution of competent disease vectors, locally acquired cases have been virtually eliminated, in part due to effective public health interventions, including vector and disease control activities. (Ebi et al., 2008; Confalonieri et al., 2007).

⁵²A zoonotic disease is any infectious disease that is able to be transmitted from an animal or nonhuman species to humans. The natural reservoir is a nonhuman reservoir.

7(d) Aeroallergens

Climate change, including changes in CO₂ concentrations, could impact the production, distribution, dispersion and allergenicity of aeroallergens and the growth and distribution of weeds, grasses, and trees that produce them (McMichael, et al., 2001; Confalonieri et al., 2007). These changes in aeroallergens and subsequent human exposures could affect the prevalence and severity of allergy symptoms. However, the scientific literature does not provide definitive data or conclusions on how climate change might impact aeroallergens and subsequently the prevalence of allergic illnesses in the United States. In addition, there are numerous other factors that affect aeroallergen levels and the prevalence of associated allergic illnesses, such as changes in land use, air pollution, and adaptive responses, many of which are difficult to assess (Ebi et al., 2008).

It has generally been observed that the presence of elevated CO₂ concentrations and temperatures stimulates plants to increase photosynthesis, biomass, water use efficiency, and reproductive effort. The IPCC concluded that pollens are likely to increase with elevated temperature and CO₂ (Field et al., 2007). Laboratory studies cited by Field et al. (2007) stimulated increased ragweed-pollen production by over 50% using a doubling of CO₂. A U.S.-based field study referenced by Field et al. (2007), which used existing temperature/CO₂ concentration differences between urban and rural areas as a proxy for climate change, found that ragweed grew faster, flowered earlier, and produced significantly greater aboveground biomass and ragweed pollen at urban locations than at rural locations.

The IPCC (Confalonieri et al., 2007) noted that climate change has caused an earlier onset of the spring pollen season in North America and that there is limited evidence that the length of the pollen season has increased for some species. However, it is unclear whether the allergenic content of these pollens has changed. The IPCC concluded that introductions of new invasive plant species with high allergenic pollen present important health risks, noting that ragweed (*Ambrosia artemisiifolia*) is spreading in several parts of the world (Confalonieri et al., 2007).

Section 8

Air Quality

Surface air concentrations of air pollutants are highly sensitive to winds, temperature, humidity, and precipitation (Denman et al., 2007). Climate change can be expected to influence the concentration and distribution of air pollutants through a variety of direct and indirect processes, including the modification of biogenic emissions, the change of chemical reaction rates, wash-out of pollutants by precipitation, and modification of weather patterns that influence pollutant buildup. In summarizing the impact of climate change on ozone and particulate matter (PM), the IPCC (Denman et al., 2007) states that “future climate change may cause significant air quality degradation by changing the dispersion rate of pollutants, the chemical environment for ozone and PM generation and the strength of emissions from the biosphere, fires and dust.”

This section describes how climate change may alter ambient concentrations of ozone and PM with associated impacts on public health and welfare in the United States.

8(a) Tropospheric Ozone

According to the IPCC (Denman et al., 2007), climate change is expected to lead to increases in regional ozone pollution in the United States and other countries. Ozone impacts on public health and welfare are described in EPA’s *Air Quality Criteria Document for Ozone* (U.S. EPA, 2006). Breathing ozone at sufficient concentrations can reduce lung function, thereby aggravating asthma or other respiratory conditions. Ozone exposure at sufficient concentrations has been associated with increases in respiratory infection susceptibility, medicine use by asthmatics, emergency department visits, and hospital admissions. Ozone exposure may contribute to premature death, especially in susceptible populations. In contrast to human health effects, which are associated with short-term exposures, the most significant ozone-induced plant effects (e.g., biomass loss, yield reductions) result from the accumulation of ozone exposures over the growing season, with differentially greater impact resulting from exposures to higher concentrations and/or longer durations.

Tropospheric ozone is both naturally occurring and, as the primary constituent of urban smog, a secondary pollutant formed through photochemical reactions involving nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. As described below, climate change can affect ozone by modifying 1) emissions of precursors, 2) atmospheric chemistry, and 3) transport and removal (Denman et al., 2007). There is now consistent evidence from models and observations that 21st century climate change will worsen summertime surface ozone in polluted regions of North America compared to a future with no climate change (Jacob and Winner, 2009).

The IPCC (Denman et al., 2007) states that, for all world regions, “climate change affects the sources of ozone precursors through physical response (lightning), biological response (soils, vegetation, and biomass burning) and human response (energy generation, land use, and agriculture).” NO_x emissions due to lightning are expected to increase in a warmer climate (Denman et al., 2007). Additionally, studies using general circulation models (GCM) concur that influx of ozone from the stratosphere to the troposphere could increase due to large-scale atmospheric circulation shifts (i.e., the Brewer-Dobson circulation) in response to climate warming (Denman et al., 2007). The sensitivity of microbial activity in soils to temperature also points toward a substantial increase in the nitric oxide emissions (Brasseur et al., 2006). As described below, biogenic VOC emissions increase with increasing temperature.

Climate-induced changes of biogenic VOC emissions alone may be regionally substantial and cause significant increases in ozone concentrations (Hauglustaine et al., 2005; Hogrefe et al., 2004; European Commission, 2003). Sensitivity simulations for the 2050s, relative to the 1990s suggest under the A2 (high-end) climate scenario that increased biogenic emissions alone add 1 to 3 ppb to summertime average daily maximum 8-hour ozone concentrations in the Midwest and along the eastern seaboard (Hogrefe et al., 2004). The IPCC (Meehl et al., 2007) reports that biogenic emissions are projected to increase by between 27 and 59%, contributing to a 30 to 50% increase in ozone formation over northern continental regions (for the 2090–2100 timeframe, relative to 1990–2000).

Consistent with this, for nearly all simulations in the EPA Interim Assessment (2009a), climate change is associated with increases in biogenic VOC emissions over most of the United States, with especially pronounced increases in the Southeast. These biogenic emissions increases do not necessarily correspond with ozone concentration increases, however. The report suggests that the response of ozone to changes in biogenic emissions depends on how isoprene chemistry is represented in the models—models that recycle isoprene nitrates back to NO_x will tend to simulate significant ozone concentration increases in regions with biogenic emissions increases, while models that do not recycle isoprene nitrates will tend to simulate small changes, or even ozone decreases.

Climate change impacts on temperature could affect ozone chemistry significantly (Denman et al., 2007). A number of studies in the United States have shown that summer daytime ozone concentrations correlate strongly with temperature. That is, ozone generally increases at higher temperatures. This correlation appears to reflect contributions of comparable magnitude from 1) temperature-dependent biogenic VOC emissions, as mentioned previously, 2) thermal decomposition of peroxyacetylnitrate (PAN), which acts as a reservoir for NO_x , as described immediately below, and 3) association of high temperatures with regional stagnation, also discussed below (Denman et al., 2007).

The EPA Interim Assessment (IA) (2009a), however, reports that considering a single meteorological variable, such as temperature, may not provide a sufficient basis for determining future ozone risks due to climate change in every region. This is consistent with the potential for different competing effects in different regions. The modeling studies found some regions of the country where simulated increases in cloud cover, and hence decreases in the amount of sunlight reaching the surface, partially counteracted the effects of warming temperatures on ozone concentrations in these regions, to go along with the many regions where the effects of temperature and cloud cover reinforced each other in producing ozone increases.

Climate change is projected to increase surface layer ozone concentrations in both urban and polluted rural environments due to decomposition of PAN at higher temperatures (Sillman and Samson, 1995; Liao and Seinfeld, 2006). Warming enhances decomposition of PAN, releasing NO_x , an important ozone precursor (Stevenson et al., 2005). Model simulations (using the high-end A2 emissions scenario) with higher temperatures for the year 2100 showed that enhanced PAN thermal decomposition caused this species to decrease by up to 50% over source regions and ozone net production to increase (Hauglustaine et al., 2005).

Atmospheric circulation can be expected to change in a warming climate and, thus, modify pollutant transport and removal. The CCSP (2008b) reports that stagnant air masses related to climate change are likely to degrade air quality in some densely populated areas. More frequent occurrences of stagnant air events in urban or industrial areas could enhance the intensity of air pollution events, although the importance of these effects is not yet well quantified (Denman et al., 2007). The IPCC (2007d) concluded that “extra-tropical storm tracks are projected to move poleward, with consequent changes in wind, precipitation, and temperature patterns, continuing the broad pattern of observed trends over the last half-century.”

The IPCC (Denman et al., 2007) cites a study for the eastern United States that found an increase in the severity and persistence of regional pollution episodes due to the reduced frequency of ventilation by storms tracking across Canada. This study found that surface cyclone activity decreased by approximately 10 to 20% in a future simulation (for 2050, under the mid-range IPCC A1B scenario), in general agreement with a number of observational studies over the northern mid-latitudes and North America. Northeast U.S. summer pollution episodes are projected in this study to increase in severity and duration; pollutant concentrations in episodes increase 5 to 10%, and episode durations increase from two to three or four days. Analysis of historical data supports both the trend in decreasing frequency of ventilation and the increase in summer pollution episodes (Leibensperger et al., 2008).

Regarding the role water vapor plays in tropospheric ozone formation, the IPCC (Denman et al., 2007) reports that simulations for the 21st century indicate a decrease in the lifetime of tropospheric ozone due to increasing water vapor. The projected increase in water vapor both decelerates the chemical production and accelerates the chemical destruction of ozone (Meehl et al., 2007). Overall, the IPCC states that climate change is expected to decrease background tropospheric ozone due to higher water vapor and to increase regional and urban-scale ozone pollution due to higher temperatures and weaker air circulation (Denman et al., 2007; Confalonieri et al., 2007).

For North America, the IPCC (Field et al., 2007) reports that surface ozone concentration may increase with a warmer climate. For the continental United States, the CCSP (2008b) report states that the northern latitudes are likely to experience the largest increases in average temperatures, and they will also bear the brunt of increases in ground-level ozone and other airborne pollutants.

Modeling studies discussed in EPA's IA (U.S. EPA, 2009a) show that simulated climate change causes increases in summertime ozone concentrations over substantial regions of the country, though this was not uniform, and some areas showed little change or decreases, though the decreases tend to be less pronounced than the increases. For those regions that showed climate-induced increases, the increase in maximum daily 8-hour average ozone concentration, a key metric for regulating U.S. air quality, was in the range of 2 to 8 ppb, averaged over the summer season. The increases were substantially greater than this during the peak pollution episodes that tend to occur over a number of days each summer. While the results from the different research groups agreed on the above points, their modeling systems did not always simulate the same regional patterns of climate-induced ozone changes across the United States. Certain regions show greater agreement than others: for example, there is more agreement on climate-induced increases for the eastern half of the country than for the West. Parts of the Southeast also show strong disagreements across the modeling groups. Where climate-change-induced increases in ozone do occur, damaging effects on ecosystems, agriculture, and health are expected to be especially pronounced, due to increases in the frequency of extreme pollution events.

The EPA IA (U.S. EPA, 2009a) suggests that climate change effects on ozone grow continuously over time, with evidence for significant increases emerging as early as the 2020s.

The results in the IA demonstrate that O₃ responds to climate change in a qualitatively consistent manner across the simulations from multiple research groups. The patterns of relative changes in regional climate vary across the same simulations. Figure 3-11 of the IA graphically illustrates the net change in daily average ozone values across the research results for summertime ozone. Ozone concentrations increase across most areas of the country with decreases limited to some parts of the Southwest. The net increases of ozone concentrations in the large population centers of the northeastern and middle Atlantic United States are the results with the highest confidence. The net increases in the Southeast and the small net changes in the Northwest are the features with the lower confidence.

The IA and the IPCC (Field et al., 2007; Wilbanks et al., 2007) cite a study that evaluates the effects of climate change on regional ozone in 15 U.S. cities, finding that average summertime daily 8-hour maximum ozone concentrations could increase by 2.7 ppb in the 2020s and by 4.2 ppb in the 2050s under the A2 (high-end) scenario.

Studies reviewed in the IA and Jacob and Winner (2009) indicate the largest increases in ozone concentrations due to climate change occur during peak pollution events. The locations of peak ozone episodes tend to be large metropolitan areas such as Los Angeles, Houston, and the Northeast corridor, suggesting higher increases of potentially dangerous levels of ozone over significant population centers. Mickley et al. (2004) find that climate change projected to occur under the A1B (mid-range) scenario results in significant changes that occur at the high end of the pollutant concentration distribution (episodes) in the Midwest and Northeast between 2000 and 2050 given constant levels of criteria pollutant emissions. Using the A2 (high-end) emissions scenario, Hogrefe et al. (2004) find that while regional climate change in the eastern United States causes the summer average daily maximum 8-hour ozone concentrations to increase by 2.7, 4.2, and 5.0 ppb in 2020s, 2050s, and 2080s (compared to 1990s), respectively, regional climate changes causes the fourth-highest summertime daily maximum 8-hour ozone concentrations to increase by 5.0, 6.4, and 8.2 ppb for the 2020s, 2050s, and 2080s, respectively (compared to 1990s) (Hogrefe et al., 2004). The CCSP (2008b) also reports climate change is projected to have a much greater impact on extreme values and to shift the distribution of ozone concentrations towards higher values, with larger relative increases in future decades. In addition, simulations reviewed in the IA showed that, for parts of the country with a defined summertime ozone season, climate change expanded its duration into the fall and spring. These findings raise particular health concerns.

The IPCC (Field et al., 2007) states that, "warming and climate extremes are likely to increase respiratory illness, including exposure to pollen and ozone." And the IPCC further states that "severe heat waves, characterized by stagnant, warm air masses and consecutive nights with high minimum temperatures will intensify in magnitude and duration over the portions of the United States and Canada, where they already occur (high confidence) (Field et al., 2007)." Further, as described in CCSP (2008b), there is some evidence that combined effects of heat stress and air pollution may be greater than simple additive effects and historical data show relationships between mortality and temperature extremes.

Holding population, dose-response characteristics, and pollution prevention measures constant, ozone-related deaths from climate change in the New York City metropolitan area are projected to increase by approximately 4.5% from the 1990s to the 2050s (under the high-end IPCC A2 scenario) (Field et al., 2007). According to the IPCC (Field et al., 2007), the "large potential population exposed to outdoor air pollution translates this small relative risk into a substantial attributable health risk." In New York City, health impacts could be further exacerbated by climate change interacting with urban heat island effects (Field et al., 2007). For A2 scenario in the 2050s, Bell et al. (2007) report that the projected effects of climate change on ozone in 50 eastern U.S. cities increased the number of summer days exceeding the 8-hour EPA standard by 68%. On average across the 50 cities, the summertime daily 8-hour maximum increased 4.4 ppb. Elevated ozone levels correspond to approximately a 0.11% to 0.27% increase in daily total mortality. The largest ozone increases are estimated to occur in cities with present-day high pollution.

As noted in CCSP (2008b), the influence of climate change on air quality will play out against a backdrop of ongoing regulatory control of both ozone and PM that will shift the baseline concentrations of these two important pollutants. Both emissions and climate changes can significantly affect ozone and PM concentrations. Thus, modeling of future emission control programs coupled with climate change does not isolate the impact of GHGs on air quality. Modeling of future climate change without future emission

control programs does isolate this impact of GHGs on air quality. Further, the range of plausible short-lived emission projections is very large. For example, emission projections used in CCSP (2008d) and in the IPCC *Fourth Assessment Report* (IPCC, 2007a) differ on whether black carbon particle and nitrogen oxides emission trends continue to increase or decrease. Improvements in our ability to project social, economic, and technological developments affecting future emissions are needed. Additionally, most studies to date that have examined potential future climate change impacts on air quality isolate the climate effect by holding precursor air pollutant emissions constant over time. For the above reasons, the analyses referenced in this TSD generally held emissions constant while varying meteorological factors consistent with future climate change.

The National Ambient Air Quality Standards (NAAQS) for ozone and their accompanying regulations have helped to reduce the dangers from ozone in the United States. However, half of all Americans—158 million people—live in counties where air pollution exceeds national health standards (U.S. EPA 2008). To predict future conditions, models are essential tools. As noted in the IA, coupling atmospheric chemical processes and the climate system presents considerable challenges because of the large number of physical, chemical, and biological processes involved, many of which are poorly understood, all interacting in complex ways. The types of modeling systems developed under this assessment permit the detailed exploration of the potential responses of air quality to climate change over the next few decades in a way that would be difficult or impossible with other approaches. They permit the systematic investigation of the multiple competing climate- and weather-related drivers of air quality interactions on the regional scale, which produce aggregate patterns of air quality change. The IPCC reports (Denman et al., 2007) that “the current generation of tropospheric ozone models is generally successful in describing the principal features of the present-day global ozone distribution.” The IPCC (Denman et al., 2007) also states that “there are major discrepancies with observed long-term trends in ozone concentrations over the 20th century” and “resolving these discrepancies is needed to establish confidence in the models.”

In addition to human health effects, elevated levels of tropospheric ozone have significant adverse effects on crop yields in the United States and other world regions, pasture and forest growth, and species composition (Easterling et al., 2007). Furthermore, the effects of air pollution on plant function may indirectly affect carbon storage; recent research showed that tropospheric ozone resulted in significantly less enhancement of carbon sequestration rates under elevated CO₂, due to negative effects of ozone on biomass productivity and changes in litter chemistry (Easterling et al., 2007).

8(b) Particulate Matter

Particulate matter (PM) effects on public health and welfare are described in EPA’s *Air Quality Criteria Document for Particulate Matter* (U.S. EPA, 2004). Particulate matter is a complex mixture of anthropogenic, biogenic, and natural materials, suspended as aerosol particles in the atmosphere. When inhaled, the smallest of these particles can reach the deepest regions of the lungs. Scientific studies have found an association between exposure to PM and significant health problems, including aggravated asthma, chronic bronchitis, reduced lung function, irregular heartbeat, heart attack, and premature death in people with heart or lung disease. Particle pollution also is the main cause of visibility impairment in the nation’s cities and national parks.

The overall directional impact of climate change on PM levels in the United States remains uncertain (CENR, 2008), as too few data yet exist on PM to draw firm conclusions about the direction or magnitude of climate impacts (CCSP, 2008b). However, preliminary results of modeling analyses reported in the EPA IA are listed below. These analyses show a range of increases and decreases in PM concentrations in different regions and for different component chemical species in the same region:

1. Precipitation is a more important primary meteorological driver of PM than of ozone, due to its role in removing PM from the atmosphere (wet deposition). Precipitation, however, is particularly difficult to model and shows greater disagreement across simulations than other variables.
2. Aerosol chemical processes, especially those concerning the formation of organic aerosols, are not fully understood and therefore not well characterized in current regional air quality models.
3. Preliminary simulation results suggest that, globally, PM generally decreases as a result of simulated climate change, due to increased atmospheric humidity and increased precipitation.
4. Regionally, simulated 2050 climate change produces increases and decreases in PM (on the order of a few percent), depending on region. For the United States, the largest simulated increases are found in the Midwest and Northeast.
5. This PM response reflects the combined climate change responses of the individual species that make up PM (e.g., sulfate, nitrate, ammonium, black carbon, organic carbon). Depending on the region, these individual responses can be in competing directions.
6. Increase in wildfire frequency associated with a warmer climate has the potential to increase PM levels in certain regions.

Further, Jacob and Winner (2009) summarize the current state of knowledge as:

“The response of PM to climate change is more complicated than that for ozone because of the diversity of PM components, compensating effects, and general uncertainty in GCM projections of the future hydrological cycle. Observations show little useful correlation of PM with climate variables to guide inferences of the effect of climate change. Rising temperature is expected to have a mild negative effect on PM due to volatilization of semi-volatile components (nitrate, organic), partly compensated by increasing sulfate production. Increasing stagnation should cause PM to increase. Precipitation frequency, which largely determines PM loss, is expected to increase globally but to decrease in southern North America and southern Europe. PM is highly sensitive to mixing depths but there is no consensus among models on how these will respond to climate change... Increases in wildfires driven by climate change could significantly increase PM concentrations beyond the direct effect of changes in meteorological variables.”

PM and PM precursor emissions are affected by climate change through physical response (windblown dust), biological response (forest fires and vegetation type/distribution), and human response (energy generation). Most natural aerosol sources are controlled by climatic parameters like wind, moisture, and temperature; thus, human-induced climate change is expected to affect the natural aerosol burden. Biogenic organic material is directly emitted into the atmosphere and produced by VOCs. All biogenic VOC emissions are highly sensitive to changes in temperature and are also highly sensitive to climate-induced changes in plant species composition and biomass distributions. Denman et al. (2007) cite a study in which biogenic emission rates are predicted to increase on average across world regions by 10% per 1°C increase in surface temperature. The response of biogenic secondary organic carbon aerosol production to a temperature change, however, could be considerably lower than the response of biogenic VOC emissions since aerosol yields can decrease with increasing temperature (Denman et al., 2007).

Particulate matter emissions from forest fires can contribute to acute and chronic illnesses of the respiratory system, particularly in children, including pneumonia, upper respiratory diseases, asthma, and chronic obstructive pulmonary diseases (Confalonieri et al., 2007). The IPCC (Field et al., 2007) reported with very high confidence that in North America, disturbances like wildfire are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons. Forest fires with their associated decrements to air quality and pulmonary effects are likely to increase in frequency, severity, distribution, and duration in the Southeast, the Intermountain West, and the West compared to a future with no climate change (CCSP, 2008b). Pollutants from forest fires can affect air quality for thousands of kilometers (Confalonieri et al., 2007). A study cited in Field et al. (2007) found that in the last three

decades the wildfire season in the western United States has increased by 78 days, and burn durations of large fires have increased from 7.5 to 37.1 days, in response to a spring-summer warming of 1.6°F (0.87°C). It also found earlier spring snowmelt has led to longer growing seasons and drought, especially at higher elevations, where the increase in wildfire activity has been greatest. Analysis by the state of California suggests that large wildfires could become up to 55% more frequent in some areas toward the end of the century due to continued global warming (California Climate Change Center, 2006).

PM chemistry is affected by changes in temperature brought about by climate change. Temperature is one of the most important meteorological variables influencing air quality in urban atmospheres because it directly affects gas and heterogeneous chemical reaction rates and gas-to-particle partitioning. The net effect that increased temperature has on airborne particle concentrations is a balance between increased production rates for secondary particulate matter (increases particulate concentrations) and increased equilibrium vapor pressures for semi-volatile particulate compounds (decreases particulate concentrations). Increased temperatures may either increase or decrease the concentration of semi-volatile secondary reaction products such as ammonium nitrate depending on ambient conditions.

Denman et al., 2007 note that there has been less work on the sensitivity of aerosols to meteorological conditions. It cites a study that produces regional model simulations for Southern California on September 25, 1996, projecting decreases in 24-hour average PM_{2.5} concentrations with increasing temperatures for inland portions of the South Coast air basin, and projecting increases for coastal regions. In CCSP (2008b), using the New York Climate and Health Project (NYCHP)-integrated model, PM_{2.5} concentrations are projected to increase with climate change, with the effects differing by component species, with sulfates and primary PM increasing markedly and with organic and nitrated components decreasing, mainly due to movement of these volatile species from the particulate to the gaseous phase.

The transport and removal of PM is highly sensitive to winds and precipitation. Removal of PM from the atmosphere occurs mainly by wet deposition (NRC, 2005). Sulfate lifetime, for example, is estimated to be reduced from 4.7 days to 4.0 days as a result of increased wet deposition (Liao and Seinfeld, 2006). Precipitation also affects soil moisture, with impacts on dust source strength and on stomatal opening/closure of plant leaves, hence affecting biogenic emissions (Denman et al., 2007). Precipitation has generally increased over land north of 30°N over the period 1900 to 2005, and it has become significantly wetter in eastern parts of North America (Trenberth et al., 2007). However, model parameterizations of wet deposition are highly uncertain and not fully realistic in their coupling to the hydrological cycle (NRC, 2005). For models to simulate accurately the seasonally varying pattern of precipitation, they must correctly simulate a number of processes (e.g., evapotranspiration, condensation, transport) that are difficult to evaluate at a global scale (Randall et al., 2007).

In 1997 (62 FR 38680), EPA concluded that particulate matter produces adverse effects on visibility, and that visibility impairment is experienced (though not necessarily attributed to climate change) throughout the United States, in multi-state regions, urban areas, and remote Federal Class I areas⁵³. Visibility impairment depends strongly on ambient relative humidity (NARSTO, 2004). Although surface specific humidity globally has generally increased after 1976 in close association with higher temperatures over both land and ocean, observations suggest that relative humidity has remained about the same overall, from the surface throughout the troposphere (Trenberth et al., 2007). Nevertheless, increases in PM due to increases in wildfires induced by climate change might increase visibility impairment.

⁵³ The Clean Air Act defines mandatory Federal Class I areas as certain national parks (greater than 6,000 acres), wilderness areas (greater than 5,000 acres), national memorial parks (greater than 5,000 acres), and international parks that were in existence as of August 7, 1977.

8(c) Health Effects Due to CO₂-Induced Increases in Tropospheric Ozone and Particulate Matter

In addition to the analyses described previously of climate change impacts on air quality, one study specifically examined the more direct effect of CO₂ on air pollution mortality. As described in the CCSP (2008b) report, using a coupled climate-air pollution three-dimensional model, a study compared the health effects of pre-industrial vs. present-day atmospheric concentrations of CO₂. The results suggest that increasing concentrations of CO₂ increased tropospheric ozone and PM_{2.5}, which increased mortality by about 1.1% per degree temperature increase over the baseline rate; the study estimated that about 40% of the increase was due to ozone and the rest to particulate matter. The estimated mortality increase was higher in locations with poorer air quality.

Section 9

Food Production and Agriculture

Food production and the agricultural sector within the United States are sensitive to short-term climate variability and long-term climate change. This section addresses how observed and projected climate change may affect U.S. food production and agriculture. Food production and agriculture here include crop yields and production, livestock production (e.g., milk and meat), freshwater fisheries, and key climate-sensitive issues for this sector including drought risk and pests and weeds.

In addition to changes in average temperatures and precipitation patterns, this section also addresses how U.S. food production and agriculture may be affected directly by elevated CO₂ levels, as well as the frequency and severity of extreme events, such as droughts and storms. Climate change-induced effects on tropospheric ozone levels and their impacts on agriculture are discussed briefly in Section 8 on Air Quality.

Vulnerability of the U.S. agricultural sector to climate change is a function of many interacting factors including pre-existing climatic and soil conditions, changes in pest competition, water availability, and the sector's capacity to respond to climate change through management practices, improved seed and cultivar technology, and changes in economic competition among regions.

The CCSP report on U.S. agriculture (Backlund et al., 2008a) made the following general conclusions for the United States:

- With increased CO₂ and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable.
- The marketable yield of many horticultural crops (e.g., tomatoes, onions, fruits) is very likely to be more sensitive to climate change than grain and oilseed crops.
- Climate change is likely to lead to a northern migration of weeds. Many weeds respond more positively to increasing CO₂ than most cash crops, particularly C3 "invasive" weeds⁵⁴. Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at the increased CO₂ levels likely in the coming decades.
- Disease pressure on crops and domestic animals will likely increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites. Regional variation in warming and changes in rainfall will also affect spatial and temporal distribution of disease.
- Projected increases in temperature and a lengthening of the growing season will likely extend forage production into late fall and early spring, thereby decreasing need for winter season forage reserves. However, these benefits will very likely be affected by regional variations in water availability.

⁵⁴ C3 and C4 refer to different carbon fixation pathways in plants during photosynthesis. C3 is the most common pathway, and C3 crops (e.g., wheat, soybeans and rice) are more responsive than C4 crops such as maize.

- Climate change-induced shifts in plant species are already underway in rangelands. Establishment of perennial herbaceous species is reducing soil water availability early in the growing season. Shifts in plant productivity and type will likely also have significant impact on livestock operations.
- Higher temperatures will very likely reduce livestock production during the summer season, but these losses will very likely be partially offset by warmer temperatures during the winter season. For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of changing climate; such protection is more frequently available for non-ruminants (e.g., swine and poultry).

The IPCC (2007b) made the following general conclusion about food production and agriculture for North America:

- Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture (water demand met primarily derived from precipitation) by 5 to 20% , but with important variability among regions. Future trends in precipitation are difficult to project but will be associated with strong regional and seasonal variation, which means some areas in United States will continue to get wetter (e.g., Northeast and large parts of the Midwest) while some areas particularly, in the West, will become drier. Major challenges are projected for crops that are near the warm end of their suitable range or depend on highly utilized water resources [high confidence].⁵⁵

9(a) Crop Yields and Productivity

Observational evidence shows that, over the last century, aggregate yields of major U.S. crops have been increasing (USDA, 2007; Field et al., 2007), with significant regional and temporal variation. Multiple factors contribute to these long-term trends, including seed technology, use of fertilizers, management practices, and climate change (i.e., lengthening of the growing season).

For projected climate change effects, the IPCC summary conclusion of net beneficial effects in the early decades in the United States under moderate climate change, with significant regional variation, is supported by a number of recent assessments for most major crops, and is consistent with the previous IPCC Third Assessment (2001) conclusion.⁵⁶ Moderate climate change for temperate regions such as the United States is described as local increases in temperature of ~2 to 5°F (~1 to 3°C), which may occur within the next few decades or past mid-century depending on scenario (see Section 6 for temperature projections). Increased average warming leads to an extended growing season, especially for northern regions of the United States. Further warming, however, is projected to have increasingly negative impacts in all regions (meaning both temperate, including the United States, and tropical regions of the world) (Easterling et al. 2007).

The CCSP report on agriculture (Hatfield et al., 2008) provides further crop-specific detail about optimum temperatures in order to assess the effects of future climate change. Crops are characterized by an upper failure-point temperature at which pollination and grain-set processes fail. Considering these aspects, Hatfield et al., (2008) detail the following optimum mean temperatures for grain yields of the major agronomic crops: 64 to 72°F (18 to 22°C) for maize, 72 to 75°F (22 to 24°C) for soybean, 59°F (15°C) for

⁵⁵ According to IPCC terminology, “high confidence” conveys an 8 out of 10 chance of being correct. See Box 12 for a full description of IPCC’s uncertainty terms.

⁵⁶ The North America chapter from the IPCC Third Assessment Report (Cohen et al., 2001) concluded: “Food production is projected to benefit from a warmer climate, but there probably will be strong regional effects, with some areas in North America suffering significant loss of comparative advantage to other regions (high confidence).”

wheat, 73 to 79°F (23 to 26°C) for rice, 77°F (25°C) for sorghum, 77 to 79°F (25 to 26°C) for cotton, 68 to 79°F (20 to 26°C) for peanut, 73 to 75°F (23 to 24°C) for dry bean, and 72 to 77°F (22 to 25°C) for tomato.

Given the variable responses of different crops to temperature (and other climatic) changes and the fact that different areas of the country specialize in different crops and have different regional climates, the variable future climate change effects among regions and crops are important to consider. The southeastern United States may be more vulnerable to increases in average temperature than more northern regions due to pre-existing temperatures that are already relatively high. Likewise, certain crops that are currently near climate thresholds (e.g., wine grapes in California) are likely to experience decreases in yields, quality, or both, even under moderate climate change scenarios (Field et al., 2007). As cited by USGCRP (Karl et al., 2009), a seemingly paradoxical impact of warming is that it appears to be increasing the risk of plant frost damage. Mild winters and warm, early springs, which are beginning to occur more frequently as climate warms, induce premature plant development and blooming, resulting in exposure of vulnerable young plants and plant tissues to subsequent late-season frosts. The 2007 spring freeze in the eastern United States caused widespread devastation of crops and natural vegetation because the frost occurred during the flowering period of many trees and during early grain development on wheat plants

Without the benefit of CO₂, the anticipated 2.2°F (1.2°C) rise in temperature over the next 30 years (a baseline assumption assumed in the CCSP (Hatfield et al., 2008) report) is projected to decrease maize, wheat, sorghum, and dry bean yields by 4.0, 6.7, 9.4, and 8.6%, respectively, in their major production regions. For soybean, the 2.2°F (1.2°C) temperature rise is projected to increase yield 2.5% in the Midwest where temperatures during July, August, and September average 72.5°F (22.5°C), but will decrease yield 3.5% in the South, where mean temperature during July, August, and September averages 80°F (26.7°C). Likewise, in the South, that same mean temperature will result in reduced rice, cotton, and peanut yields, which will decrease 12.0, 5.7, and 5.4%, respectively (Hatfield et al., 2008). An anticipated CO₂ increase from 380 to 440 ppm is projected to increase maize and sorghum yield by only 1%, whereas the listed C3 crops will increase yield by 6.1 to 7.4%, except for cotton, which shows a 9.2% increase (Hatfield et al., 2008).

Changes in precipitation patterns will play a large role in determining the net impacts of climate change at the national and sub-national scales, where there is considerable variation and precipitation changes remain difficult to predict. Information on regional precipitation patterns in the United States is provided in Section 15. The IPCC (Field et al., 2007) reviewed integrated assessment modeling studies exploring the interacting impacts of climate and economic factors on agriculture, water resources, and biome boundaries in the United States and concluded that scenarios with decreased precipitation create important challenges, restricting the availability of water for irrigation and at the same time increasing water demand for irrigated agriculture, as well as urban and ecological uses. The critical importance of specific agro-climatic events, such as last frost, also introduces uncertainty in future projections (Field et al., 2007).

There is still uncertainty about the sensitivity of crop yields in the United States and other world regions to the direct effects of elevated CO₂ levels. The IPCC (Easterling et al., 2007) concluded that elevated CO₂ levels are expected to contribute to small beneficial impacts on crop yields. The IPCC confirmed the general conclusions from its previous *Third Assessment Report* in 2001. Experimental research on crop responses to elevated CO₂ through the FACE (Free Air CO₂ Enrichment)⁵⁷ experiments indicate that, at ambient CO₂ concentrations of 550 ppm (approximately double the concentration from pre-industrial

⁵⁷ <http://www.bnl.gov/face/>

times), crop yields increase under unstressed conditions by 10 to 25% for C3 crops and by 0 to 10% for C4 crops (medium confidence). Crop model simulations under elevated CO₂ are consistent with these ranges (high confidence) (Easterling et al., 2007). Carbon dioxide also makes some plants more water-use efficient, meaning they produce more plant material, such as grain, on less water. This is a benefit in water-limited areas and in seasons with less than normal rainfall (Karl et al., 2009). High temperatures, water and nutrient availability, and ozone exposure, however, can significantly limit the direct stimulatory CO₂ response.

Hatfield et al. (2008) provides further detail about individual crop species responses to elevated CO₂ concentrations and the interactive effects with other climate change factors. Overall, the benefits of CO₂ rise over the next 30 years are projected to mostly offset the negative effects of temperature for most C3 crops except rice and bean, while the C4 crop yields are reduced by rising temperature because they have little response to the CO₂ rise (Hatfield et al., 2008). Thus, according to Hatfield et al. (2008), the 30-year outlook for U.S. crop production is relatively neutral. However, the outlook for U.S. crop production over the next 100 years would not be as optimistic, if temperature continues to rise along with climbing CO₂ concentrations, because the C3 response to rising CO₂ is reaching a saturating plateau, while the negative temperature effects will become progressively more severe (Hatfield et al., 2008).

There are continual changes in the genetic resources of crop varieties and horticultural crops that will provide increases in yield due to increased resistance to water and pest stresses. These need to be considered in any future assessments of the climatic impacts; however, the genetic modifications have not altered the basic temperature response or CO₂ response of the biological system (Hatfield et al., 2008).

Although horticultural crops (fruits, vegetables and nuts) account for more than 40% of total crop market value in the United States (2002 Census of Agriculture), there is relatively little information on their response to CO₂, and few reliable crop simulation models for use in climate change assessments compared to that which is available for major grain and oilseed crops (Hatfield et al., 2008). The marketable yield of many horticultural crops is likely to be more sensitive to climate change than grain and oilseed crops because even short-term, minor environmental stresses can negatively affect visual and flavor quality (Hatfield et al., 2008).

9(b) Irrigation Requirements

The impacts of climate change on irrigation water requirements may be large (Easterling et al., 2007). The IPCC considered this to be a new, robust finding since the *Third Assessment Report* in 2001. The increase in irrigation demand due to climate change is expected in the majority of world regions including the United States due to decreased rainfall in certain regions and/or increased evaporation arising from increased temperatures. Longer growing seasons may contribute to the increased irrigation demands as well. Hatfield et al. (2008) describe studies that examine changes in irrigation required for the United States under climate change scenarios. For corn, a study cited in Hatfield et al. (2008) calculated that by 2030, irrigation requirements will change from -1 (Lower Colorado Basin) to +451% (Lower Mississippi Basin), because of rainfall variation. Given the variation in the sizes and baseline irrigation requirements of U.S. basins, a representative figure for the overall U.S. increase in irrigation requirements is 64% if stomatal effects are ignored, or 35% if they are included. Similar calculations were made for alfalfa, for which overall irrigation requirements are predicted to increase 50 and 29% in the next 30 years in the cases of ignoring and including stomatal effects, respectively. These increases are more likely due to the decrease in rainfall during the growing season and the reduction in soil water availability.

9(c) Climate Variability and Extreme Events

Weather events are a major factor in annual crop yield variation. The projected impacts of climate change often consider changes in *average* temperature and precipitation patterns alone, while not reflecting the potential for altered variability in events such as droughts and floods. The potential for these events to change in frequency and magnitude introduces a key uncertainty regarding future projections of changes in agricultural and food production due to climate change. On this issue, the IPCC (Easterling et al. 2007) drew the following conclusion: “Recent studies indicate that climate change scenarios that include increased frequency of heat stress, droughts and flooding events reduce crop yields and livestock productivity beyond the impacts due to changes in mean variables alone, creating the possibility for surprises. Climate variability and change also modify the risks of fires, and pest and pathogen outbreaks, with negative consequences for food, fiber and forestry (high confidence).” The adverse effects on crop yields due to droughts and other extreme events may offset the beneficial direct effects of elevated CO₂, moderate temperature increases over the near term and longer growing seasons.

Drought events are already a frequent occurrence, especially in the western United States. Vulnerability to extended drought is, according to IPCC (Field et al., 2007), increasing across North America as population growth and economic development increase demands from agricultural, municipal, and industrial uses, resulting in frequent over-allocation of water resources. Though droughts occur more frequently and intensely in the western part of the United States, the East is not immune from droughts and attendant reductions in water supply, changes in water quality and ecosystem function, and challenges in allocation (Field et al., 2007).

Average annual precipitation is projected to decrease in the southwestern United States but increase over the rest of North America (Christensen et al., 2007). Some studies project widespread increases in extreme precipitation (Christensen et al., 2007), with greater risks of not only flooding from intense precipitation, but also droughts from greater temporal variability in precipitation. Increased runoff due to intense precipitation on crop fields and animal agriculture operations may result in an increased contribution of sediments, nutrients, pathogens, and pesticides in surface waters (Kundzewicz et al., 2007).

One economic consequence of excessive rainfall is delayed spring planting, which jeopardizes profits for farmers paid a premium for early season production of high-value horticultural crops such as melon, sweet corn, and tomatoes (Hatfield et al., 2008). Field flooding during the growing season causes crop losses associated with anoxia, increases susceptibility to root diseases, increases soil compaction (due to use of heavy farm equipment on wet soils), and causes more runoff and leaching of nutrients and agricultural chemicals into ground water and surface water (Hatfield et al., 2008).

9(d) Pests and Weeds

Pests and weeds can reduce crop yields, cause economic losses to farmers, and require management control options. How climate change (elevated CO₂, increased temperatures, altered precipitation patterns, and changes in the frequency and intensity of extreme events) might affect the prevalence of pests and weeds is an issue of concern for food production and the agricultural sector. Recent warming trends in the United States have led to earlier insect spring activity and proliferation of some species (Easterling, et al., 2007).

The growth of many crops and weeds is being stimulated (Backlund et al., 2008a). Weeds generally respond more positively to increasing CO₂ than most cash crops, particularly C3 invasive weeds; and while there are many weed species that have the C4 photosynthetic pathway and therefore show a smaller response to atmospheric CO₂ relative to C3 crops, in most agronomic situations, crops are in competition

with both C3 and C4 weeds (Backlund et al., 2008a). The IPCC (Easterling et al., 2007) concluded, with high confidence, that climate variability and change modify the risks of fires, and pest and pathogen outbreaks, with negative consequences for food, fiber, and forestry across all world regions.

Climate change is likely to lead to a northern migration of weeds (Backlund et al., 2008a). Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at the increased CO₂ levels likely in the coming decades (Backlund et al., 2008a).

Disease pressure on crops and domestic animals will likely increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites. Regional variation in warming and changes in rainfall will also affect the spatial and temporal distribution of diseases (Backlund et al., 2008a).

Most studies, however, continue to investigate pest damage as a separate function of either elevated ambient CO₂ concentrations or temperature. Pests and weeds are additional factors that, for example, are often omitted when projecting the direct stimulatory effect of elevated CO₂ on crop yields. Research on the combined effects of elevated CO₂ and climate change on pests, weeds and disease is still insufficient for U.S. and world agriculture (Easterling et al., 2007).

9(e) Livestock

Hatfield et al. (2008) describe how temperature changes and environmental stresses can result in declines in physical activity and an associated decline in eating and grazing activity (for ruminants and other herbivores) or elicit a panting or shivering response, which increases maintenance requirements of the animal and contributes to decreases in animal productivity.

Climate change has the potential to influence livestock productivity in a number of ways. Elevated CO₂ concentrations can affect forage quality; thermal stress can directly affect the health of livestock animals; an increase in the frequency or magnitude of extreme events can lead to livestock loss; and climate change may affect the spread of animal diseases. The IPCC has generated a number of new conclusions in this area compared to the *Third Assessment Report* in 2001. These conclusions (Easterling et al., 2007), along with those from the more recent CCSP report (Hatfield et al., 2008) include:

- Higher temperatures will very likely reduce livestock production during the summer season, but these losses will very likely be partially offset by warmer temperatures during the winter season. For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of a changing climate; such protection is more frequently available for non-ruminants (e.g., swine and poultry).
- Based on expected vegetation changes and known environmental effects on forage protein, carbohydrate, and fiber contents, both positive and negative changes in forage quality are possible as a result of atmospheric and climatic change. Elevated CO₂ can increase the carbon-to-nitrogen ratio in forages and thus reduce the nutritional value of those grasses, which in turn affects animal weight and performance. Under elevated CO₂, a decrease of C4 grasses and an increase of C3 grasses (depending upon the plant species that remain) may occur, which could potentially reduce or alter the nutritional quality of the forage grasses available to grazing livestock; however the exact effects on both types of grasses and their nutritional quality still needs to be determined.
- Increased climate variability (including extremes in both heat and cold) and droughts may lead to livestock loss. The impact on animal productivity due to increased variability in weather patterns will likely be far greater than effects associated with the average change in climatic conditions.

9(f) Freshwater and Marine Fisheries

Freshwater fisheries are sensitive to changes in temperature and water supply, which affect flows of rivers and streams, as well as lake levels. Climate change can interact with other factors that affect the health of fish and productivity of fisheries (e.g., habitat loss, land-use change).

The IPCC (Field et al., 2007 and references therein) reviewed a number of North American studies showing how freshwater fish are sensitive to, or are being affected by, observed changes in climate:

- Cold- and cool-water fish, especially salmonids, have been declining as warmer/drier conditions reduce their habitat. The sea-run salmon stocks are in steep decline throughout much of North America.
- Pacific salmon have been appearing in Arctic rivers.⁵⁸
- Salmonid species have been affected by warming in U.S. streams.
- Success of adult spawning and survival of fry brook trout is closely linked to cold ground water seeps, which provide preferred temperature refuges for lake-dwelling populations. Rates of fish egg development and mortality increase with temperature rise within species-specific tolerance ranges.

Regarding the impacts of future climate change, IPCC concluded, with high confidence for North America, that cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges (Field et al., 2007). A number of specific impacts by fish species and region in North America are projected (Field et al., 2007 and references therein):

- Salmonids, which prefer cold water, are likely to experience the most negative impacts.
- Arctic freshwaters will likely be most affected, as they will experience the greatest warming.
- Many warm-water and cool-water species will shift their ranges northward or to higher altitudes.
- In the continental United States, cold-water species will likely disappear from all but the deeper lakes, cool-water species will be lost mainly from shallow lakes, and warm water species will thrive except in the far south, where temperatures in shallow lakes will exceed survival thresholds.

Climate variability and change can also impact fisheries in coastal and estuarine waters, although non-climatic factors, such as overfishing and habitat loss and degradation, are already responsible for reducing fish stocks (Nicholls et al., 2007). Coral reefs, for example, are vulnerable to a range of stresses and for many reefs, thermal stress thresholds will be crossed, resulting in bleaching, with severe adverse consequences for reef-based fisheries (Nicholls et al., 2007). Increased storm intensity, temperature, and salt-water intrusion in coastal water bodies can also adversely impact coastal fisheries production.

⁵⁸ Arctic includes large regions of Alaska, and the Alaskan indigenous population makes up largest indigenous population of the Arctic (see ACIA, 2004).

Section 10

Forestry

This section addresses how climate change may affect forestry, including timber yields, wildfires and drought risk, forest composition, and pests in the United States.

The CCSP report addressing forestry and land resources (Ryan et al., 2008) notes climate strongly influences forest productivity, species composition, and the frequency of and magnitude of disturbances that impact forests and made the following general conclusions for the United States:

- Climate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska, and will continue to do so. An increased frequency of disturbance (such as drought, storms, insect outbreaks, and wildfire) is at least as important to ecosystem function as incremental changes in temperature, precipitation, atmospheric CO₂, nitrogen deposition, and ozone pollution. Disturbances partially or completely change forest ecosystem structure and species composition, cause short-term productivity and carbon storage loss, allow better opportunities for invasive alien species to become established, and command more public and management attention and resources.
- Rising CO₂ will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils.
- Nitrogen deposition and warmer temperatures have very likely increased forest growth where water is not limiting and will continue to do so in the near future.
- The combined effects of expected increased temperature, CO₂, nitrogen deposition, ozone, and forest disturbance on soil processes and soil carbon storage remain unclear.

Globally, the IPCC (Easterling et al., 2007) concludes that modeling studies predict increased global timber production but that regional production will exhibit large variability. However, it notes CO₂ enrichment effects may be overestimated in models.

For North America, the IPCC (Field et al., 2007) concludes:

- Overall forest growth in North America will likely increase modestly (10 to 20%) as a result of extended growing seasons and elevated CO₂ over the next century but with important spatial and temporal variation (medium confidence).⁵⁹
- Disturbances like wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons (very high confidence). Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services.
- Over the 21st century, pressure for tree species to shift north and to higher elevations will fundamentally rearrange North American ecosystems. Differential capacities for range shifts and

⁵⁹ According to IPCC terminology, “medium confidence” conveys a 5 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC’s uncertainty terms.

constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

10(a) Forest Productivity

Forestry productivity is known to be sensitive to changes in climate variables (e.g. temperature, radiation, precipitation, water vapor pressure in the air, and wind speed), as these affect a number of physical, chemical, and biological processes in forest systems (Easterling, et al., 2007). However, as noted in a CCSP report addressing the forest sector (Ryan et al., 2008), it is difficult to separate the role of climate from other potentially influencing factors, particularly because these interactions vary by location.

For the United States as a whole, forest growth and productivity have been observed to increase since the middle of the 20th century, in part due to observed climate change. Nitrogen deposition and warmer temperatures have very likely increased forest growth where water is not limiting (Ryan et al., 2008). The IPCC (Field et al., 2007 and references therein) outlines a number of studies demonstrating the observed connection between changes in U.S. forest growth and changes in climate variables:

- Forest growth appears to be slowly accelerating (less than 1% per decade) in regions where tree growth has historically been limited by low temperatures and short growing seasons.
- The length of the vegetation growing season has increased an average of two days per decade since 1950 in the conterminous United States, with most of the increase resulting from earlier spring warming.
- Growth is slowing in areas subject to drought.
- On dry south-facing slopes in Alaska, growth of white spruce has decreased over the last 90 years, due to increased drought stress.
- In semi-arid forests of the southwestern United States, growth rates have decreased since 1895, correlated with drought from warming temperatures.
- Mountain forests are increasingly encroached upon from other species native to adjacent lowlands, while simultaneously losing high altitude habitats due to warming (Fischlin et al., 2007).
- In Colorado, aspen have advanced into the more cold-tolerant spruce-fir forests over the past 100 years.
- A combination of warmer temperatures and insect infestations has resulted in economically significant losses of the forest resource base in Alaska.

Forest productivity gains may result through: 1) the direct stimulatory CO₂ fertilization effect (although the magnitude of this effect remains uncertain over the long term and can be curtailed by other changing factors); 2) warming in cold climates, given concomitant precipitation increases to compensate for possibly increasing water vapor pressure deficits; and 3) precipitation increases under water-limited conditions (Fischlin et al., 2007). Most trees and shrubs use the C3 photosynthetic pathway, which means they respond more favorably to CO₂ enrichment than plants that use the C4 pathway increasing the competitive ability of C3 versus C4 plants in water-limited systems (Ryan et al., 2008).

New studies suggest that direct CO₂ effects on tree growth may be lower than previously assumed (Easterling et al., 2007). Additionally, the initial increase in growth increments may be limited by competition, disturbance, air pollutants (primarily tropospheric ozone), nutrient limitations, ecological processes, and other factors, and the response is site- and species-specific (Easterling et al., 2007). Similarly, Ryan et al. (2008) stated that, where nutrients are not limiting, rising CO₂ increases photosynthesis and wood production (with younger stands responding most strongly), but that on infertile soils the extra carbon from increased photosynthesis will be quickly respired.

The general findings from a number of recent syntheses using data from the three American and one European CO₂-enrichment FACE study sites show that North American forests will absorb more CO₂ and might retain more carbon as atmospheric CO₂ increases. The increase in the rate of carbon sequestration will be highest (mostly in wood) on nutrient-rich soils with no water limitation and will decrease with decreasing fertility and water supply. Several yet unresolved questions prevent a definitive assessment of the effect of elevated CO₂ on other components of the carbon cycle in forest ecosystems (Ryan et al., 2008).

Precipitation and weather extremes are key to many forestry impacts, accounting for part of the regional variability in forest response (Easterling et al., 2007). Ryan et al. (2008) note forest productivity varies with annual precipitation across broad gradients and with interannual variability within sites. They conclude if existing trends in precipitation continue:

- Forest productivity will likely decrease in the Interior West, the Southwest, eastern portions of the Southeast, and Alaska.
- Forest productivity will likely increase in the northeastern United States, the Lake States, and in western portions of the Southeast.

They also state an increase in drought events will very likely reduce forest productivity wherever these events occur.

As with crop yields, ozone pollution will modify the effects of elevated CO₂ and any changes in temperature and precipitation, but these multiple interactions are difficult to predict because they have been poorly studied (Ryan et al., 2008). Nitrogen deposition has likely increased forest growth rates over large areas, and interacts positively to enhance the forest growth response to increasing CO₂. These effects are expected to continue in the future as nitrogen deposition and rising CO₂ continue.

For the projected temperature increases over the next few decades, most studies support the conclusion that a modest warming of a few degrees Celsius will lead to greater tree growth in the United States. Simulations with yield models show that climate change can increase global timber production through location changes of forests and higher growth rates, especially when positive effects of elevated CO₂ concentration are taken into consideration (Easterling et al., 2007). There are many causes for this enhancement including direct physiological CO₂ effects, a longer growing season, and potentially greater mineralization of soil nutrients. Because different species may respond somewhat differently to warming, the competitive balance of species in forests may change. Trees will probably become established in formerly colder habitats (more northerly, higher altitude) than at present (Ryan et al., 2008).

Productivity gains in one area can occur simultaneously with productivity losses in other areas. For a widespread species like lodgepole pine, a 3°C temperature increase would increase growth in the northern part of its range, decrease growth in the middle, and decimate southern forests (Field et al., 2007). Climate change is expected to increase California timber production by the 2020s because of stimulated growth in the standing forest. In the long run (up to 2100), these productivity gains would be offset by reductions in productive area for softwoods growth. Risks of losses from southern pine beetle likely depend on the seasonality of warming, with winter and spring warming leading to the greatest damage (Easterling et al., 2007 and references therein).

10(b) Wildfire and Drought Risk

While in some cases a changing climate may have positive impacts on the productivity of forest systems, changes in disturbance patterns are expected to have a substantial impact on overall gains or losses. More prevalent forest fire disturbances have recently been observed in the United States and other world

regions (Fischlin, et al., 2007). According to a study cited in the recent USGCRP report (Karl et al., 2009), Alaska has experienced large increases in fire, with the area burned more than doubling in recent decades, and as in the western United States higher, air temperature is a key factor. Wildfires and droughts, among other extreme events (e.g., hurricanes) that can cause forest damage, pose the largest threats over time to forest ecosystems.

Several lines of evidence suggest that large, stand-replacing wildfires will likely increase in frequency over the next several decades because of climate warming (Ryan et al., 2008). General climate warming encourages wildfires by extending the summer period that dries fuels, promoting easier ignition and faster spread (Field et al., 2007).

The IPCC (Field et al., 2007 and references therein) noted a number of observed changes to U.S. wildfire size and frequency, often associating these changes with changes in average temperatures:

- Since 1980, an average of about 22,000 km² yr⁻¹ (8,500 mi² yr⁻¹) has burned in wildfires, almost twice the 1920–1980 average of about 13,000 km² yr⁻¹ (5,020 mi² yr⁻¹).
- The forested area burned in the western United States from 1987–2003 is 6.7 times the area burned from 1970–1986.
- Human vulnerability to wildfires has increased, with a rising population in the wildland-urban interface.
- In the last three decades, the wildfire season in the western United States has increased by 78 days, and burn durations of fires greater than 1,000 hectares (ha) (2,470 acres) have increased from 7.5 to 37.1 days, in response to a spring/summer warming of 1.6°F (0.87°C).
- Earlier spring snowmelt has led to longer growing seasons and drought, especially at higher elevations, where the increase in wildfire activity has been greatest.
- In the southwestern United States, fire activity is correlated with ENSO positive phases (La Niña) and higher Palmer Drought Severity Indices.⁶⁰ El Niño events tend to bring wetter conditions to the southwest, enhancing the production of fine fuels⁶¹ and, La Niña events tend to bring drier conditions. Major fire years tend to follow the switching from El Niño to La Niña conditions due to buildup of material during wet years followed by desiccation during a dry year, whereas small fires are strongly associated directly with previous year drought. Other modes of atmospheric and oceanic variability are known to impact temperature and precipitation (Gutowski et al., 2008) and hence wildfire patterns and activity.
- Increased temperature in the future will likely extend fire seasons throughout the western United States, with more fires occurring earlier and later than is currently typical, and will increase the total area burned in some regions.

Though fires and extreme events are not well represented in models, current climate modeling studies suggest that increased temperatures and longer growing seasons will elevate fire risk in connection with increased aridity. Some research identifies the possibility of a 10% increase in the seasonal severity of fire hazard over much of the United States under climate change (Easterling, et al., 2007). For Arctic regions, forest fires are expected to increase in frequency and intensity (ACIA, 2004). In California, the risk of increased wildfires as a result of climate change has been identified as a significant issue (California Energy Commission, 2006).

⁶⁰ The Palmer Drought Severity Index (PDSI), used by NOAA, uses a formula that includes temperature and rainfall to determine dryness. It is most effective in determining long-term drought. Positive PDSI indicates wet conditions, and negative PDSI indicates dry conditions.

⁶¹ Fine fuels are defined as fast-drying fuels which are less than 1/4-inch (0.64 cm) in diameter. These fuels (e.g., grass, leaves, needles) ignite readily and are consumed rapidly by fire when dry.

10(c) Forest Composition

Climate change and associated changes in disturbance regimes will cause shifts in the distributions of tree species and alter forest species composition. With warming, forests will extend further north and to higher elevations. Over currently dry regions, increased precipitation may allow forests to displace grasslands and savannas. Changes in forest composition in turn can alter the frequencies, intensities, and impacts of disturbances such as fire, insect outbreaks, and disease.

In Alaska and neighboring Arctic regions, there is strong evidence of recent vegetation composition change, as outlined by the IPCC (Anisimov et al., 2007 and references therein):

- Aerial photographs show increased shrub abundance in 70% of 200 locations.
- Along the Arctic to sub-Arctic boundary, the tree-line has moved about 6 mi (10 km) northwards, and 2% of Alaskan tundra on the Seward Peninsula has been displaced by forest in the past 50 years.
- The pattern of northward and upward tree-line advances is comparable with earlier Holocene changes.
- Analyses of satellite images indicate that the length of growing season is increasing by three days per decade in Alaska.

Likely rates of migration northward and to higher elevations are uncertain and depend not only on climate change but also on future land-use patterns and habitat fragmentation, which can impede species migration. Evidence of shifts in tree species has been observed in the Green Mountains of Vermont where temperatures have risen 2 to 4°F (4 to 7°C) in the last 40 years. As reported by USGCRP, the ranges of some mountain tree species in this region have shifted to higher elevations by 350 feet (107 m) in the last 40 years (Karl et al., 2009). Tree communities were relatively unchanged at low and high elevations but in mid-elevation transition zones, the changes have been dramatic. Tree species suited to cold conditions in the Green Mountains declined from 43 to 18% while species suited to warmer conditions increased from 57 to 82%.

Bioclimate modeling based on outputs from five general circulation models suggests increases in tree species richness in the Northwest and decreases in the Southwest on long time scales (millennia). Over the next century, however, even positive long-term species richness may lead to short-term decreases because species that are intolerant of local conditions may disappear relatively quickly while migration of new species into the area may be quite slow (Field, et al., 2007). The Arctic Climate Impact Assessment (ACIA, 2004) also concluded that vegetation zones are projected to migrate northward, with forests encroaching on tundra and tundra encroaching on polar deserts. Limitations in amount and quality of soils are likely to hinder these poleward shifts.

10(d) Insects and Diseases

Insects and diseases are a natural part of forested ecosystems and outbreaks often have complex causes. The effects of insects and diseases can vary from defoliation and retarded growth, to timber damage, to massive forest diebacks. Insect life cycles can be a factor in pest outbreaks; and insect life cycles are sensitive to climate change. Many northern insects have a two-year life cycle, and warmer winter temperatures allow a larger fraction of overwintering larvae to survive. Recently, spruce budworm in Alaska has completed its life cycle in one year, rather than the previously observed duration of two years (Field et al., 2007). Recent warming trends in the United States have led to earlier spring activity of insects and proliferation of some species, such as the mountain pine beetle (Easterling et al., 2007). During the 1990s, Alaska's Kenai Peninsula experienced an outbreak of spruce bark beetle over 6,200 square miles (16,000 km²) with 10 to 20% tree mortality (Anisimov et al., 2007). Also following recent

warming in Alaska, spruce budworm has reproduced farther north reaching problematic numbers (Anisimov et al., 2007). Climate change may indirectly affect insect outbreaks by affecting the overall health and productivity of trees. For example, susceptibility of trees to insects is increased when multi-year droughts degrade the trees' ability to generate defensive chemicals (Field, et al., 2007). Warmer temperatures have already enhanced the opportunities for insect spread across the landscape in the United States and other world regions (Easterling et al., 2007).

The IPCC (Easterling et al., 2007) stated that modeling of future climate change impacts on insect and pathogen outbreaks remains limited. Nevertheless, the IPCC (Field et al., 2007) states with high confidence that, across North America, impacts of climate change on commercial forestry potential are likely to be sensitive to changes in disturbances from insects and diseases, as well as wildfires.

The CCSP report (Ryan et al., 2008) states that the ranges of the mountain pine beetle and southern pine beetle are projected to expand northward as a result of average temperature increases. Increased probability of spruce beetle outbreak as well as increase in climate suitability for mountain pine beetle attack in high-elevation ecosystems has also been projected in response to warming (Ryan et al., 2008).

Climate change can shift the current boundaries of insects and pathogens and modify tree physiology and tree defense. An increase in climate extremes may also promote plant disease and pest outbreaks (Easterling et al., 2007).

Section 11

Water Resources

This section covers climate change effects on U.S. water supply, water quality, extreme events affecting water resources, and water uses. Information about observed trends as well as projected impacts is provided.

The vulnerability of freshwater resources in the United States to climate change varies from region to region. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations (Lettenmaier et al., 2008). Examples of large U.S. water bodies where climate change raises a concern include the Great Lakes, Chesapeake Bay, Gulf of Mexico, and the Columbia River Basin.

For North America, the IPCC (Field et al., 2007) concluded:

- Climate change will constrain North America's overallocated water resources, increasing competition among agricultural, municipal, industrial, and ecological uses (very high confidence)⁶². Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal availability of water. Higher demand from economic development, agriculture and population growth will further limit surface and ground water availability. In the Great Lakes and major river systems, lower levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and binational relationships.

11(a) Water Supply and Snowpack

Surface Water and Snowpack

The semi-humid conditions of the eastern United States transition to drier conditions in the West that are interrupted by the Rocky Mountains. The driest climates, however, exist in the Intermountain West and Southwest, becoming more humid toward the west and north to more humid conditions on the upslope areas of the Cascade and coastal mountain ranges, especially in the Pacific Northwest (Lettenmaier et al., 2008).

The IPCC and USGCRP reviewed a number of studies showing trends in U.S. precipitation patterns, surface water supply, and snowpack, and how climate change may be contributing to some of these trends (Field et al., 2007; Karl et al., 2009):

- On average, annual precipitation has increased throughout most of North America. However, much of the Southeast and West has experienced reductions in precipitation and increases in drought severity and duration, especially in the Southwest (Field et al., 2007).
- Streamflow in the eastern United States has increased 25% in the last 60 years but has decreased by about 2% per decade in the central Rocky Mountain region over the last century (Field et al., 2007).
- Since 1950, stream discharge in both the Colorado and Columbia river basins has decreased (Field et al., 2007).

⁶² According to IPCC terminology, "very high confidence" conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC's uncertainty terms.

- Over the past 50 years, there have been widespread temperature-related reductions in snowpack in the West, with the largest reductions occurring in lower elevation mountains in the Northwest and California where snowfall occurs at temperatures close to the freezing point (Karl et al., 2009).
- In regions with winter snow, warming has shifted the magnitude and timing of hydrologic events. The fraction of annual precipitation falling as rain (rather than snow) increased at 74% of the weather stations studied in the western mountains of the United States from 1949 to 2004 (Field et al., 2007). Runoff in snowmelt-dominated areas is occurring up to 20 days earlier or more in the West, and up to 14 days earlier in the Northeast (Karl et al., 2009).
- Spring and summer snow cover has also decreased in the U.S. West (Field et al., 2007).
- Break-up of river and lake ice across North America advanced by 0.2 to 12.9 days over the last 100 years (Field et al., 2007).

In the Arctic, precipitation has increased by about 8% on average over the past century. Much of the increase has fallen as rain, with the largest increases occurring in autumn and winter. Later freeze-up and earlier break-up of river and lake ice have combined to reduce the ice season by one to three weeks in some areas. Glaciers throughout North America are melting, and the particularly rapid retreat of Alaskan glaciers represents about half of the estimated loss of glacial mass worldwide (ACIA, 2004). Permafrost plays a large role in the hydrology of lakes and ponds. The spatial pattern of lake disappearance strongly suggests that permafrost thawing is driving the changes. These changes to Arctic precipitation, ice extent, and glacial abundance will affect key regional biophysical systems, act as climatic feedbacks (primarily by changing surface albedo), and have socioeconomic impacts (high confidence) (Anisimov et al., 2007).

In regions including the Colorado River, Columbia River, and Ogallala Aquifer, surface and/or ground water resources are intensively used and subject to competition from agricultural, municipal, industrial, and ecological needs. This increases the potential vulnerability to future changes in timing and availability of water (Field et al., 2007).

Climate change has already altered, and will continue to alter, the water cycle, affecting where, when, and how much water is available for all uses (Karl et al., 2009). With higher temperatures, the water-holding capacity of the atmosphere and evaporation into the atmosphere increase, and this favors increased climate variability, with more intense precipitation and more droughts (Kundzewicz et al., 2007). Projections for the western mountains of the United States suggest that warming, and changes in the form, timing, and amount of precipitation will very likely (high confidence) lead to earlier melting and significant reductions in snowpack by the middle of the 21st century (Lettenmaier et al., 2008; Field et al., 2007). In mountainous snowmelt-dominated watersheds, projections suggest advances in the timing of snowmelt runoff, increases in winter and early spring flows (raising flooding potential), and substantially decreased summer flows. Heavily utilized water systems of the western United States that rely on capturing snowmelt runoff, such as the Columbia River system, will be especially vulnerable (Field et al., 2007). Reduced snowpack has been identified as a major concern for the state of California (California Energy Commission, 2006).

Globally, current water management practices are very likely to be inadequate to reduce the negative impacts of climate change on water supply reliability, flood risk, and aquatic ecosystems (very high confidence) (Kundzewicz et al., 2007). Less reliable supplies of water are likely to create challenges for managing urban water systems as well as for industries that depend on large volumes of water. It is projected that the negative impacts of climate change on freshwater systems outweigh its benefits (high confidence). Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources (very high confidence). The beneficial impacts of increased annual runoff in other areas will be tempered by the negative effects of increased precipitation variability and

seasonal runoff shifts on water supply, water quality, and flood risks (high confidence) (Kundzewicz, 2007).

U.S. water managers currently anticipate local, regional, or state-wide water shortages over the next 10 years. Threats to reliable supply are complicated by high population growth rates in western states where many resources are at or approaching full utilization. In eastern North America, daily precipitation so heavy that it now occurs only once every 20 years is projected to occur approximately every eight years by the end of this century, under a mid-range emissions scenario (CCSP, 2008i). Potential increases in heavy precipitation, with expanding impervious surfaces, could increase urban flood risks and create additional design challenges and costs for stormwater management (Field et al., 2007). The IPCC (Field et al., 2007 and references therein) reviewed several regional-level studies on climate change impacts to U.S. water management which showed:

- In the Great Lakes–St. Lawrence Basin, many, but not all, assessments project lower net basin supplies and lake water levels. Lower water levels are likely to influence many sectors, with multiple, interacting impacts (IPCC: high confidence). Atmosphere–lake interactions contribute to the uncertainty in assessing these impacts.
- Urban water supply systems in North America often draw water from considerable distances, so climate impacts need not be local to affect cities. By the 2020s, 41% of the water supply to southern California is likely to be vulnerable due to snowpack loss in the Sierra Nevadas and Colorado River basin.
- The New York area will likely experience greater water supply variability. New York City’s system can likely adapt to future changes, but the region’s smaller systems may be vulnerable, leading to a need for enhanced regional water distribution plans.

In the Arctic, river discharge to the ocean has increased during the past few decades, and peak flows in the spring are occurring earlier. These changes are projected to accelerate with future climate change. Snow cover extent in Alaska is projected to decrease by 10 to 20% by the 2070s, with greatest declines in spring (ACIA, 2004 and reference therein).

The IPCC concluded with high confidence that under most climate change scenarios, water resources in small islands around the globe are likely to be seriously compromised (Mimura et al., 2007). Most small islands have a limited water supply, and water resources in these islands are especially vulnerable to future changes and distribution of rainfall. Reduced rainfall typically leads to decreased surface water supply and slower recharge rates of the freshwater lens⁶³, which can result in prolonged drought impacts. Many islands in the Caribbean (which include U.S. territories of Puerto Rico and U.S. Virgin Islands) and Pacific (including American Samoa, the Marshall Islands, and Republic of Palau) are likely to experience increased water stress as a result of climate change. Under all SRES scenarios, reduced rainfall in summer is projected for the Caribbean, making it unlikely that the demand for water resources will be met. Increased rainfall in winter is unlikely to compensate for these water deficits due to lack of storage capacity (Mimura et al., 2007).

Ground Water

Ground water systems generally respond more slowly to climate change than surface water systems. Limited data on existing supplies of ground water makes it difficult to understand and measure climate

⁶³ Freshwater lens is defined as a relatively thin layer of freshwater within island aquifer systems that floats on an underlying mass of denser seawater. Numerous factors control the shape and thickness of the lens, including the rate of recharge from precipitation, island geometry, and geologic features such as the permeability of soil layers.

effects. In general, ground water levels correlate most strongly with precipitation, but temperature becomes more important for shallow aquifers, especially during warm periods. In semi-arid and arid areas, ground water resources are particularly vulnerable because precipitation and streamflow are concentrated over a few months, year-to-year variability is high, and deep ground water wells or reservoirs generally do not exist (Kundzewicz et al., 2007).

With climate change, availability of ground water is likely to be influenced by changes in withdrawals (reflecting development, demand, and availability of other sources) and recharge (determined by temperature, timing, and amount of precipitation, and surface water interactions) (medium confidence). In general, simulated aquifer levels respond to changes in temperature, precipitation, and the level of withdrawal. According to IPCC, base flows were found to decrease in scenarios that are drier or have higher pumping rates, and increase in wetter scenarios on average across world regions (Kundzewicz et al., 2007). Changes in vegetation and soils that occur as temperature changes or due to fire or pest outbreaks are also likely to affect recharge by altering evaporation and infiltration rates. More frequent and larger floods are likely to increase ground water recharge in semi-arid and arid areas, where most recharge occurs through dry streambeds after heavy rainfalls and floods (Karl et al., 2009).

Projections suggest that efforts to offset declining surface water availability by increasing ground water withdrawals will be hampered by decreases in ground water recharge in some water-stressed regions, such as the southwest United States. Vulnerability in these areas is also often exacerbated by the rapid increase of population and water demand (high confidence) (Kundzewicz et al., 2007). Projections for the Ogallala aquifer region suggest that natural ground water recharge decreases more than 20% in all simulations with different climate models and future warming scenarios of 4.5°F (2.5°C) or greater (Field et al., 2007 and reference therein).

In addition, sea level rise will extend areas of salinization of ground water and estuaries, resulting in a decrease in freshwater availability for humans and ecosystems in coastal areas. For a discussion of these impacts, see Section 12.

11(b) Water Quality

The IPCC concluded with high confidence that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution and can impact ecosystems, human health, and water system reliability and operating costs (Kundzewicz et al., 2007). A CCSP (2008e) report also acknowledges that water quality is sensitive to both increased water temperatures and changes in precipitation; however, most water quality changes observed so far in the United States are likely attributable to causes other than climate change.

Pollutants of concern particularly relevant to climate change effects include sediment, nutrients, organic matter, pathogens, pesticides, salt, and thermal pollution (Kundzewicz et al., 2007). The IPCC (Kundzewicz et al., 2007) reviewed several studies discussing the observed impacts of climate change on water quality that showed:

- In lakes and reservoirs, climate change effects are primarily caused by water temperature variations. These variations can be caused by climate change or indirectly through increases in thermal pollution as a result of higher demand for cooling water in the energy sector. This affects, for the United States and all world regions, dissolved oxygen regimes, redox potentials⁶⁴, lake stratification, mixing rates, and the development of aquatic biota, as they all depend on water temperature. Increasing water

⁶⁴ Redox potential is defined as the tendency of a chemical species to acquire electrons and therefore be reduced.

temperature affects the self-purification capacity of rivers by reducing the amount of dissolved oxygen available for biodegradation.

- Water pollution problems are exacerbated during low flow conditions where small water quantities result in less dilution and greater concentrations of pollutants.
- Heavy precipitation frequencies in the United States were at a minimum in the 1920s and 1930s and have increased through the 1990s (Field, et al., 2007). Increases in intense rain events result in the introduction of more sediment, nutrients, pathogens, and toxics into water bodies from non-point sources but these events also provide the pulse flow needed for some ecosystems.

North American simulations of future surface and bottom water temperatures of lakes, reservoirs, rivers, and estuaries consistently increase, with summer surface temperatures exceeding 86°F (30°C) in Midwestern and southern lakes and reservoirs. The IPCC projects that warming is likely to extend and intensify summer thermal stratification in surface waters, further contributing to oxygen depletion (Field et al., 2007 and references therein). Oxygen is essential for most living things, and its availability is reduced at higher temperatures both because the amount that can be dissolved in water is lower and because respiration rates of living things are higher. Low oxygen stresses aquatic animals such as coldwater fish and the insects and crustaceans on which they feed. Lower oxygen levels also decrease the self-purification capabilities of rivers (Karl et al., 2009).

Climate models consistently project that the eastern United States will experience increased runoff, while there will be substantial declines in the interior West, especially the Southwest. While this represents the projected general trends, important regional and seasonal differences exist, and there is less agreement among model projections for some areas (e.g., the Southeast). Projections for runoff in California and other parts of the West also show reductions, although less than in the interior West (Karl et al., 2009). Higher water temperature and variations in runoff are likely to produce adverse changes in water quality affecting human health, ecosystems, and water uses. Elevated surface water temperatures will promote algal blooms and increases in bacteria and fungi levels. Increases in water temperature can also make some contaminants, such as ammonia (U.S. EPA, 1999), more toxic for some species and foster the growth of microbial pathogens in sources of drinking water. Warmer waters also transfer volatile and semi-volatile compounds (ammonia, mercury, polychlorinated biphenyls [PCBs], dioxins, pesticides) from surface water bodies to the atmosphere more rapidly (Kundzewicz et al., 2007). Although this transfer will improve water quality, this may have implications for air quality.

Lowering of the water levels in rivers and lakes can lead to re-suspension of bottom sediments and liberating compounds, with negative effects on water supplies (Field et al., 2007 and references therein). These impacts can lead to a bad odor and taste in chlorinated drinking water and greater occurrence of toxins. More intense rainfall will lead to increases in suspended solids (turbidity) and pollutant levels in water bodies due to soil erosion (Kundzewicz et al., 2007). Moreover, even with enhanced phosphorus removal in wastewater treatment plants, algal growth in water bodies may increase with warming over the long term. Increasing nutrient and sediment loads due to more intense runoff events will negatively affect water quality, requiring additional treatment to render it suitable for drinking water.

In coastal areas, precipitation increases on land have increased river runoff, polluting coastal waters with more nitrogen and phosphorous, sediments, and other contaminants (Karl et al., 2009). The direct influence of sea level rise on freshwater resources comes principally from seawater intrusion into surface waters and coastal aquifers and further encroachment of saltwater into estuaries and coastal river systems. These changes can have significant impacts on coastal populations relying on surface water or coastal aquifers for drinking water (Nicholls et al., 2007).

Climate change is likely to make it more difficult to achieve existing water quality goals for sediment (IPCC: high confidence) because hydrologic changes affect many geomorphic processes including soil erosion, slope stability, channel erosion, and sediment transport (Field et al., 2007). IPCC reviewed a number of region-specific studies on U.S. water quality and projected that:

- Changes in precipitation may increase nitrogen loads from rivers in the Chesapeake and Delaware Bay regions by up to 50% by 2030 (Kundzewicz et al., 2007 and reference therein).
- Decreases in snow cover and increases in winter rain on bare soil will likely lengthen the erosion season and enhance erosion intensity. This will increase the potential for sediment-related water quality impacts in agricultural areas without appropriate soil management techniques (Field et al., 2007 and reference therein). All studies on soil erosion suggest that increased rainfall amounts and intensities will lead to greater rates of erosion, within the United States and in other regions, unless protection measures are taken (Kundzewicz et al., 2007). Soil management practices (e.g., crop residue, no-till) in some regions (e.g., the Corn Belt) may not provide sufficient erosion protection against future intense precipitation and associated runoff (Field et al., 2007).

11(c) Extreme Events

There are a number of climatic and non-climatic drivers influencing flood and drought impacts. Whether risks are realized depends on several factors. Floods can be caused by intense and/or long-lasting precipitation events, rapid snowmelt, dam failure, or reduced conveyance due to ice jams or landslides. Flood magnitude and spatial extent depend on the intensity, volume, and time of precipitation, and the antecedent conditions of rivers and their drainage basins (e.g., presence of snow and ice, soil composition, level of human development, existence of dikes, dams, and reservoirs) (Kundzewicz et al., 2007).

Precipitation intensity will increase across the United States, but particularly at mid- and high latitudes where mean precipitation also increases. This increase will affect the risk of flash flooding and urban flooding (Kundzewicz et al., 2007). Some studies project widespread increases in extreme precipitation with greater risks of not only flooding from intense precipitation but also droughts from greater temporal variability in precipitation. In general, projected changes in precipitation extremes are larger than changes in mean precipitation (Field et al., 2007).

It is likely that anthropogenic warming has increased the impacts of drought over North America in recent decades, but the magnitude of the effect is uncertain (CCSP, 2008g). The socioeconomic impacts of droughts arise from the interaction between climate, natural conditions, and human factors such as changes in land use. In dry areas, excessive water withdrawals from surface and ground water sources can exacerbate the impacts of drought (Kundzewicz et al., 2007). Although drought has been more frequent and intense in the western part of the United States, the East is also vulnerable to droughts and attendant reductions in water supply, changes in water quality and ecosystem function, and challenges in allocation (Field et al., 2007).

An additional impact of greenhouse warming is a likely increase in evapotranspiration during drought episodes, thus sustaining and amplifying impacts, because of warmer land surface temperatures. This effect would not have initiated drought conditions but would be an additional factor, one that is likely to grow as climate warms and result in longer, more intense droughts. Hence, by adding additional water stress, warming can exacerbate naturally occurring droughts, in addition to influencing the meteorological conditions responsible for drought (Hoerling et al., 2008).

In addition to the effects on water supply, extreme events, such as floods and droughts, will likely reduce water quality. Increased erosion and runoff rates during flood events will wash pollutants (e.g., organic matter, fertilizers, pesticides, heavy metals) from soils into water bodies, with subsequent impacts to species and ecosystems. Heavy rains and floods beyond the design capacity of water treatment systems will likely cause overflows of combined sewer systems⁶⁵ and untreated wastewater discharges from overwhelmed or damaged wastewater treatment plants, resulting in impaired water quality and risks to human health (Karl et al., 2009). During drought events, the lack of precipitation and subsequent low flow conditions will impair water quality by reducing the amount of water available to dilute pollutants. These effects from floods and droughts will make it more difficult to achieve pollutant discharge limits and water quality goals (Kundzewicz et al., 2007).

11(d) Implications for Water Uses

There are many competing water uses in the United States that will be adversely impacted by climate change impacts to water supply and quality. Furthermore, the past century is no longer a reasonable guide to the future for water management (Karl et al., 2009). The IPCC reviewed a number of studies describing the impacts of climate change on water uses in the United States that showed:

- Decreased water supply and lower water levels are likely to exacerbate challenges relating to navigation in the United States (Field et al., 2007). Some studies have found that low-flow conditions may restrict ship loading in shallow ports and harbors (Kundzewicz et al., 2007). However, navigational benefits from climate change exist as well. For example, the navigation season for the North Sea Route is projected to increase from the current 20 to 30 days per year to 90 to 100 days by 2080 (ACIA, 2004 and references therein).
- Climate change impacts to water supply and quality will affect agricultural practices, including the increase of irrigation demand in dry regions and the aggravation of non-point source water pollution problems in areas susceptible to intense rainfall events and flooding (Field et al., 2007). For more information on climate change impacts to agriculture, see Section 9.
- The U.S. energy sector, which relies heavily on water for generation (hydropower) and cooling capacity, will be adversely impacted by changes to water supply and quality in reservoirs and other water bodies (Wilbanks et al., 2007). For more information on climate change impacts to the energy sector, see Section 13.
- Climate-induced environmental changes (e.g., loss of glaciers, reduced river discharge in some regions, reduced snow fall in winter) will affect park tourism, winter sport activities, inland water sports (e.g., fishing, rafting, boating), and other recreational uses dependent upon precipitation (Field et al., 2007). While the North American tourism industry acknowledges the important influence of climate, its impacts have not been analyzed comprehensively.
- Ecological uses of water could be adversely impacted by climate change. Temperature increases and changed precipitation patterns alter flow and flow timing. These changes will threaten aquatic ecosystems (Kundzewicz et al., 2007). For more information, on climate change impacts on ecosystems and wildlife, see Section 14.
- By changing the existing patterns of precipitation and runoff, climate change will further stress existing water disputes across the United States. Disputes currently exist in the Klamath River, Sacramento Delta, Colorado River, Great Lakes region, and Apalachicola-Chattahoochee-Flint River system (Karl et al., 2009).

⁶⁵ Combined sewer systems are an older infrastructure design that carries storm water and sewage in the same pipes. During heavy rains, these systems often cannot handle the volume, and untreated sewage is discharged into lakes or waterways, including drinking water supplies and places where people swim.

Section 12

Sea Level Rise and Coastal Areas

This section discusses areas in the United States vulnerable to sea level rise, associated interactions with coastal development, important coastal processes, observed and projected impacts, and how climate change effects on extreme events will impact coastal areas. Information on the observed and projected rates of sea level rise due to climate change can be found in Sections 4(g) and 6(c), respectively. Information on ocean acidification is discussed in Sections 4(l), 6(b), and 14(a).

The IPCC (Field et al., 2007) concluded the following when considering how climate change effects, including sea level rise, may result in impacts to North American coasts:

- Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution (very high confidence).⁶⁶ Sea level is rising along much of the coast, and the rate of change will increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion.
- Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, other coastal habitats, and dependent species are threatened by sea level rise, fixed structures blocking landward migration, and changes in vegetation. Population growth and rising value of infrastructure in coastal areas increases vulnerability to climate variability and future climate change.

12(a) Vulnerable Areas

Interaction With Coastal Zone Development

Coastal population growth in deltas, barrier islands, and estuaries has led to widespread conversion of natural coastal landscapes to agriculture and aquaculture as well as industrial and residential uses. According to NOAA (Crossett et al., 2004), approximately 153 million people (53% of the total population) lived in the 673 U.S. coastal counties⁶⁷ in 2003. This represents an increase of 33 million people since 1980, and by 2008, the number was projected to rise to 160 million. This population growth, the rising value of coastal property, and the projected increases in storm intensity have increased the vulnerability of coastal areas to climate variability and future climate change (IPCC, 2007b).

For small islands, the coastline is long, relative to island area. As a result, many resources and ecosystem services are threatened by a combination of human pressures and climate change effects, including sea level rise, increases in sea surface temperature, and possible increases in extreme weather events (Mimura et al., 2007).

Coastal and ocean activities contribute more than \$1 trillion to the U.S. gross domestic product (Karl et al., 2009). Although climate change is impacting coastal systems, non-climate human impacts have been more damaging over the past century. The major non-climate impacts for the United States and other world regions include drainage of coastal wetlands, resource extraction⁶⁸, deforestation, introductions of invasive species, shoreline protection, and the discharge of sewage, fertilizers, and contaminants into

⁶⁶ According to IPCC terminology, “very high confidence” conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC’s uncertainty terms.

⁶⁷ “Coastal county” is generally defined in NOAA reports as a county in which at least 15% of its total land area is located within a coastal watershed.

⁶⁸ Resource extraction activities in coastal areas include sand/coral mining, hydrocarbon production, and commercial and recreational fishing.

coastal waters (Nicholls et al., 2007). The cumulative effect of these non-climate, anthropogenic impacts increases the vulnerability of coastal systems to climate-related stressors.

Coastal Processes

Climate change and sea level rise affect sediment transport in complex ways. Erosion and ecosystem loss is affecting many parts of the U.S. coastline, but it remains unclear to what extent these losses result from climate change instead of land loss associated with relative sea level rise due to subsidence and other human drivers (Nicholls et al., 2007).

Coastal wetland loss is also being observed in the United States where these ecosystems are squeezed between natural and artificial landward boundaries and rising sea levels, a process known as “coastal squeeze” (Field et al., 2007). The degradation of coastal ecosystems, especially wetlands and coral reefs, can have serious implications for the well-being of societies dependent on them for goods and services (Nicholls et al., 2007). For more information regarding climate change impacts to coral reefs, see Section 14.

Engineering structures, such as bulkheads, dams, channelizations, and diversions of coastal waterways, limit sediment supply to coastal areas. Wetlands are especially threatened by sea level rise when insufficient amounts of sediment from upland watersheds are deposited on them. If sea level rises slowly, the balance between sediment supply and morphological adjustment can be maintained if a salt marsh vertically accretes⁶⁹, or a lagoon infills, at the same rate. However, an acceleration in the rate of sea level rise may mean that coastal marshes and wetlands cannot keep up, particularly where the supply of sediment is limited (e.g., where coastal floodplains are inundated after natural levees or artificial embankments are overtopped) (Nicholls et al., 2007).

Although open coasts have been the focus of research on erosion and shore stabilization technology, sheltered coastal areas in the United States are also vulnerable and suffer secondary effects from rising seas (NRC, 2006a). For example, barrier island erosion in Louisiana has increased the height of waves reaching the shorelines of coastal bays. This has enhanced erosion rates of beaches, tidal creeks, and adjacent wetlands. The impacts on gravel beaches have received less attention than sandy beaches; however these systems are threatened by sea level rise, even under high wetland accretion rates. The persistence of gravel and cobble-boulder beaches will also be influenced by storms, tectonic events, and other factors that build and reshape these highly dynamic shorelines (Nicholls et al., 2007).

Observed Changes

According to the IPCC, most of the world’s sandy shorelines retreated during the past century, and climate change-induced sea level rise is one underlying cause. Over the past century in the United States, more than 50% of the original salt marsh habitat has been lost. In Mississippi and Texas, over half of the shorelines eroded at average rates of 8.5 to 10 feet yr⁻¹ (2.6 to 3.1 m yr⁻¹) since the 1970s, while 90% of the Louisiana shoreline eroded at a rate of 39 feet yr⁻¹ (12.0 m yr⁻¹) (Nicholls et al., 2007 and references therein). High rates of relative sea level rise, coupled with cutting off the supply of sediments from the Mississippi River and other human alterations, have resulted in the loss of 1,900 square miles (4900 km²) of Louisiana’s coastal wetlands during the past century, weakening their capacity to absorb the storm surge of hurricanes such as Katrina (Karl et al., 2009).

⁶⁹ The term “vertical accretion” is defined as the accumulation of sediments and other materials in a wetland habitat that results in build-up of the land in a vertical direction.

In the Great Lakes where sea level rise is not a concern, both extremely high and low water levels resulting from changes to the hydrological cycle have been damaging and disruptive to shoreline communities (Nicholls et al., 2007). Future changes to the hydrological cycle brought on by climate change may exacerbate these effects (Field et al., 2007; Bates et al., 2008). High lake water levels increase storm surge flooding, accelerate shoreline erosion, and damage industrial and commercial infrastructure located on the shore. Conversely, low lake water levels can pose problems for navigation, expose intake/discharge pipes for electrical utilities and municipal water treatment plants, and cause unpleasant odors.

In the Arctic, coastal stability is affected by factors common to all areas (e.g., shoreline exposure, relative sea level change, climate, and local geology), and by factors specific to the high latitudes (e.g., low temperatures, ground ice, and sea ice) (Anisimov et al., 2007). Adverse impacts have already been observed along Alaskan coasts, and traditional knowledge points to widespread coastal change in Alaska. Rising temperatures in Alaska are reducing the thickness and spatial extent of sea ice. This creates more open water and allows for winds to generate stronger waves, which increase shoreline erosion. Sea level rise and thawing of coastal permafrost exacerbate this problem. Higher waves will create even greater potential for this kind of erosion damage (ACIA, 2004).

Projected Impacts

The U.S. coastline is long and diverse with a wide range of coastal characteristics. Sea level rise changes the shape and location of coastlines by moving them landward along low-lying contours and exposing new areas to erosion (NRC, 2006a). Coasts subsiding due to natural or human-induced causes will experience larger relative rises in sea level. In some locations, such as deltas and coastal cities (e.g., the Mississippi delta and surrounding cities), this effect can be significant (Nicholls et al., 2007). Rapid development, including an additional 25 million people in the coastal United States over the next 25 years, will further reduce the resilience of coastal areas to rising sea levels (Field et al., 2007). Superimposed on the impacts of erosion and subsidence, the effects of rising sea level will exacerbate the loss of waterfront property and increase vulnerability to inundation hazards (Nicholls et al., 2007). Cities such as New Orleans, Miami, and New York are particularly at risk, and could have difficulty coping with the sea level rise projected by the end of the century under a higher emissions scenario (Karl et al., 2009).

If sea level rise occurs over the next century at a rate consistent with the higher range of the 2007 IPCC scenarios (i.e., 1.6 to 2.0 feet (50 to 60 cm) rise in sea level by 2100), it is about as likely as not that some barrier island coasts in the mid-Atlantic region will cross a geomorphic threshold and experience significant changes. Such changes include more rapid landward migration or barrier island segmentation (Gutierrez et al., 2009).

Up to 21% of the remaining coastal wetlands in the U.S. Mid-Atlantic region are potentially at risk of inundation between 2000 and 2100 (Field et al., 2007 and reference therein). Rates of coastal wetland loss, in the Chesapeake Bay and elsewhere, will increase with accelerated sea level rise, in part due to "coastal squeeze" (IPCC: high confidence). It is virtually certain that those tidal wetlands already experiencing submergence by sea level rise, and associated high rates of loss will continue to lose area in the future due to both accelerated rates sea level rise as well as changes in other environmental and climate drivers (Cahoon et al., 2009). Salt-marsh biodiversity is likely to decrease in northeastern marshes through expansion of non-native species such as cordgrass (*Spartina alterniflora*), at the expense of high-marsh species (Field et al., 2007). The IPCC (Field et al., 2007) projects that many U.S. salt marshes in less developed areas can potentially keep pace with sea level rise through vertical accretion. Furthermore, the CCSP concluded that those wetlands keeping pace with 20th century rates of sea level rise would survive a 0.08 inch (0.2 cm) yr⁻¹ acceleration of sea level rise only under optimal hydrology

and sediment supply conditions, and would not survive a 0.3 inch (0.7 cm) yr⁻¹ acceleration of sea level rise (Cahoon et al., 2009).

Climate change is likely to have a strong impact on saltwater intrusion into coastal sources of ground water in the United States and other world regions. Sea level rise and high rates of water withdrawal promote the intrusion of saline water into the ground water supplies, which adversely affects water quality. Reduced ground water recharge associated with decreases in precipitation and increased evapotranspiration⁷⁰ will exacerbate sea level rise effects on salinization rates (Kundzewicz et al., 2007). This effect could impose enormous costs on water treatment infrastructure (i.e., costs associated with relocating infrastructure or building desalinization capacity), especially in densely populated coastal areas. Saltwater intrusion is also projected to occur in freshwater bodies along the coast. Estuarine and mangrove ecosystems can withstand a range of salinities on a short term basis; however, they are unlikely to survive permanent exposure to high salinity environments. Saltwater intrusion into freshwater rivers has already been linked with the decline of bald cypress forests in Louisiana and cabbage palm forests in Florida. Given that these ecosystems provide a variety of ecosystem services and goods (e.g., spawning habitat for fish, pollutant filtration, sediment control, storm surge attenuation), the loss of these areas could be significant (Kundzewicz et al., 2007).

The vulnerable nature of coastal indigenous communities to climate change arises from their geographical location, reliance on the local environment for aspects of everyday life such as diet and economy, and the current state of social, cultural, economic, and political change taking place in these regions (Anisimov et al., 2007). Sea ice extent in the Arctic Ocean is expected to continue to decrease and may even disappear entirely during summer months in the coming decades. This reduction of sea ice increases extreme coastal erosion in Arctic Alaska, due to the increased exposure of the coastline to strong wave action (CCSP, 2008i). These effects, along with sea level rise, will accelerate the already high coastal erosion rates in permafrost-rich areas of Alaska's coastline, thereby forcing the issue of relocation for threatened settlements. It has been estimated that relocating the village of Kivalina, Alaska, to a nearby site would cost \$54 million (Anisimov et al., 2007).

For small islands, some studies suggest that sea level rise could reduce island size, particularly in the Pacific, raising concerns for Hawaii and other U.S. territories (Mimura et al., 2007). In some cases, accelerated coastal erosion may lead to island abandonment, as has been documented in the Chesapeake Bay. Island infrastructure tends to predominate in coastal locations. In the Caribbean and Pacific islands, more than 50% of the population lives within 0.9 mi (1.5 km) of the shore. International airports, roads, capital cities, and other types of infrastructure are typically sited along the coasts of these islands as well. Therefore, the socioeconomic well-being of island communities will be threatened by inundation, storm surge, erosion, and other coastal hazards resulting from climate change (high confidence) (Mimura et al., 2007).

12(b) Extreme Events

Although increases in mean sea level over the 21st century and beyond will inundate unprotected, low-lying areas, the most devastating impacts are likely to be associated with storm surge. Superimposed on accelerated sea level rise, the present storm and wave climatology and storm surge frequency distributions suggest more severe coastal flooding and erosion hazards (Nicholls et al., 2007). Higher sea level provides an elevated base for storm surges to build upon and diminishes the rate at which low-lying areas drain, thereby increasing the risk of flooding from rainstorms (CCSP, 2009b). In New York City and

⁷⁰ Evapotranspiration is defined as the total amount of evaporation from surface water bodies (e.g., lakes, rivers, reservoirs), soil, and plant transpiration. In this context, warmer temperatures brought on by climate change will drive greater levels of evapotranspiration.

Long Island, flooding from a combination of sea level rise and storm surge could be several meters deep (Field et al., 2007). Projections suggest that the return period of a 100-year flood event in this area might be reduced to 19 to 68 years, on average, by the 2050s, and to four to 60 years by the 2080s (Wilbanks et al., 2007; and references therein).

Additionally, some major urban centers in the United States are situated in low-lying flood plains. For example, areas of New Orleans and its vicinity are 59 to 118 inches (150 to 300 cm) below sea level. Considering the rate of subsidence and using a mid-range estimate of 19 inches (48 cm) sea level rise by 2100, it is projected that this region could be 98 to 157 inches (250 to 400 cm) or more below mean sea level by 2100 (Field et al., 2007). In this scenario, a storm surge from a Category 3 hurricane (estimated at 118 to 157 inches (300 to 400 cm) without waves) could be 20 to 23 feet (6 to 7 m) above areas that were heavily populated in 2004 (Field et al., 2007 and references therein).

The IPCC discusses a number of other extreme event scenarios and observations with implications for coastal areas of the United States (see also Section 6(f) for a discussion of abrupt changes and sea level rise):

- Very large sea level rises that would result from widespread deglaciation of Greenland and West Antarctic ice sheets imply major changes in coastlines and ecosystems, and inundation of low-lying areas, with greatest effects in river deltas. Relocating populations, economic activity, and infrastructure would be costly and challenging (IPCC, 2007b).
- Under El Niño conditions, high water levels combined with changes in winter storms along the Pacific coast have produced severe coastal flooding and storm impacts. In San Francisco, 140 years of tide-gauge data suggest an increase in severe winter storms since 1950, and some studies have detected accelerated coastal erosion (Field et al., 2007).
- Recent winters with less ice in the Great Lakes and Gulf of St. Lawrence have increased coastal exposure to damage from winter storms (Field et al., 2007).
- Recent severe tropical and extra-tropical storms demonstrate that North American urban centers with assumed high adaptive capacity remain vulnerable to extreme events (Field et al., 2007).

Demand for waterfront property and building land in the United States continues to grow, increasing the value of property at risk. Of the \$19 trillion value of all insured residential and commercial property in the U.S. states exposed to North Atlantic hurricanes, \$7.2 trillion (41%) is located in coastal counties⁷¹. According to a study referenced in Field et al. (2007), this economic value includes 79% of the property in Florida, 63% of property in New York, and 61% of the property in Connecticut. The devastating effects of hurricanes Ivan in 2004 and Katrina, Rita, and Wilma in 2005 illustrate the vulnerability of North American infrastructure and urban systems that were not designed or not maintained to adequate safety margins. When protective systems fail, impacts can be widespread and multi-dimensional (Field et al., 2007).

⁷¹ "Coastal county" is generally defined in NOAA reports as a county in which at least 15% of its total land area is located within a coastal watershed.

Section 13

Energy, Infrastructure, and Settlements

According to the IPCC (Wilbanks et al., 2007), “[i]ndustries, settlements and human society are accustomed to variability in environmental conditions, and in many ways they have become resilient to it when it is a part of their normal experience. Environmental changes that are more extreme or persistent than that experience, however, can lead to vulnerabilities, especially if the changes are not foreseen and/or if capacities for adaptation are limited.”

Climate change is likely⁷² to affect U.S. energy use and energy production, physical infrastructures, and institutional infrastructures and will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements (Wilbanks et al., 2007), particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles (ACIA, 2004). Climate warming will be accompanied by decreases in demand for heating energy and increases in demand for cooling energy (Karl et al., 2009). These changes will vary by region and by season, but they will affect household and business energy costs and their demands on energy supply institutions. The latter will result in significant increases in electricity use and higher peak demand in most regions (Karl et al., 2009). Other effects on energy consumption are less clear (CCSP, 2007a).

13(a) Heating and Cooling Requirements

With climate warming, less heating is required for industrial, commercial, and residential buildings in the United States, but more cooling is required, with changes varying by region and by season. Net energy demand at a national scale will be influenced by the structure of the energy supply. The main source of energy for cooling is electricity, while coal, oil, gas, biomass, and electricity are used for space heating. Regions with substantial requirements for both cooling and heating could find that net annual electricity demands increase while demands for other heating energy sources decline. Critical factors for the United States are the relative efficiency of space cooling in summer compared to space heating in winter and the relative distribution of populations in colder northern or warmer southern regions. Seasonal variation in total demand is also important. In some cases, due to infrastructure limitations, peak demand could go beyond the maximum capacity of the electricity transmission system (Wilbanks et al., 2007). An increase in peak demand can lead to a disproportionate increase in energy infrastructure investment (Karl et al., 2009).

Recent North American studies generally confirm earlier work showing a small net change (increase or decrease, depending on methods, scenarios, and location) in net demand for energy in buildings but a significant increase in demand for electricity for space cooling, with further increases caused by additional market penetration of air conditioning (high confidence) (Field et al., 2007). Generally speaking, the net effects of climate change in the United States on total energy demand are projected to amount to between perhaps a 5% increase and decrease in demand per 1°C in warming in buildings. Existing studies do not agree on whether there would be a net increase or decrease in energy consumption with changed climate because a variety of methodologies have been used (CCSP, 2007a).

In California, if temperatures rise according to a high scenario range (8 to 10.5°F [~4.5 to 5.6°C]), annual electricity demand for air conditioning could increase by as much as 20% by the end of the century (relative to the 1961–1990 base period, assuming population remains unchanged and limited

⁷² According to IPCC terminology, “likely” conveys a 66 to 90% probability of occurrence. See Box 1.2 for a full description of IPCC’s uncertainty terms.

implementation of efficiency measures) (California Energy Commission, 2006)⁷³. In Alaska, there will be savings on heating costs; modeling has predicted a 15% decline in the demand for heating energy in the populated parts of the Arctic and sub-Arctic and up to one month decrease in the duration of a period when heating is needed (Anisimov et al., 2007).

Overall, both net delivered energy and net primary energy consumption increase or decrease only a few percent with a 2 or 4°F [1 or 2°C] warming; however, there is a robust result that, in the absence of an energy efficiency policy directed at space cooling, climate change would cause a significant increase in the demand for electricity in the United States, which would require the building of additional electricity generation capacity (and probably transmission facilities) worth many billions of dollars (CCSP, 2007a).

Beyond the general changes described above, general temperature increases can mean changes in energy consumption in key climate-sensitive sectors of the economy, such as transportation, construction, agriculture, and others. Furthermore, there may be increases in energy used to supply other resources for climate-sensitive processes, such as pumping water for irrigated agriculture and municipal uses (CENR, 2008).

13(b) Energy Production

Climate change could affect U.S. energy production and supply a) if extreme weather events become more intense, b) where regions dependent on water supplies for hydropower and/or thermal power plant cooling face reductions or increases in water supplies, c) where changed conditions affect facility siting decisions, and d) where climatic conditions change (positively or negatively) for biomass, wind power, or solar energy production (Wilbanks et al., 2007; CCSP 2007a).

Significant uncertainty exists about the potential impacts of climate change on energy production and distribution, in part because the timing and magnitude of climate impacts are uncertain. Nonetheless, every existing source of energy in the United States has some vulnerability to climate variability. Renewable energy sources tend to be more sensitive to climate variables, but fossil energy production can also be adversely effected by air and water temperatures, and the thermoelectric cooling process that is critical to maintaining high electrical generation efficiencies also applies to nuclear energy. In addition, extreme weather events have adverse effects on energy production, distribution, and fuel transportation (CCSP, 2007a).

Fossil and Nuclear Energy

Climate change impacts on U.S. electricity generation at fossil and nuclear power plants are likely to be similar. The most direct climate impacts are related to power plant cooling and water availability. As currently designed, power plants require significant amounts of water, and they are vulnerable to fluctuations in water supply. Regional-scale changes would likely mean that some areas would see significant increases in water availability while other regions would see significant decreases. In those areas seeing a decline, the impact on power plant availability or even siting new capacity could be significant. Plant designs are flexible and new technologies for water reuse, heat rejection, and use of alternative water sources are being developed; but, at present, some impact—significant on a local level—can be foreseen (CCSP, 2007a).

⁷³ Temperature projections for the state of California are based on IPCC global emissions scenarios as discussed in Section 6(a).

Renewable Energy

Because renewable energy depends directly on ambient natural resources such as hydrological resources, wind patterns and intensity, and solar radiation, it is likely to be more sensitive to climate variability than fossil or nuclear energy systems that rely on geological stores. Renewable energy systems in the United States are also vulnerable to damage from extreme weather events (CCSP, 2007a).

Hydropower generation is sensitive to the amount, timing, and geographical pattern of precipitation as well as temperature (rain or snow, timing of melting). Reduced streamflows are expected to jeopardize hydropower production in some areas of the United States, whereas greater streamflows, depending on their timing, might be beneficial (Wilbanks et al., 2007; Bates et al., 2008). In California, where hydropower now comprises about 15% of in-state energy production, diminished snow melt flowing through dams will decrease the potential for hydropower production by up to 30% if temperatures rise to the medium warming range by the end of the century (~5.5 to 8°F [-3.1 to 4.4°C] increase in California) and precipitation decreases by 10 to 20%. However, future precipitation projections are quite uncertain so it is possible that precipitation may increase and expand hydropower generation (California Energy Commission, 2006).

North American wind and solar resources are about as likely as not to increase (medium confidence). Studies to date project wind resources that are either unchanged by climate change, or reduced by 0 to 40%. Future changes in cloudiness could slightly increase the potential for solar energy in North America south of 60°N, but one study projected that increased cloudiness will likely decrease the output of photovoltaics by 0 to 20% (Field et al., 2007).

Bioenergy potential is climate-sensitive through direct impacts on crop growth and availability of water for irrigation and biofuel processing purposes. Warming and precipitation increases are expected to allow the bioenergy crop switchgrass, for instance, to compete effectively with traditional crops in central United States (Field et al., 2007). Renewable energy production is highly susceptible to localized and regional changes in the resource base. As a result, the greater uncertainties on regional impacts under current climate change modeling pose a significant challenge in evaluating medium to long-term impacts on renewable energy production (CCSP, 2007a).

Energy Supply and Transmission

Extreme weather events can threaten coastal energy infrastructures and electricity transmission and distribution infrastructures in the United States and other world regions (Wilbanks et al., 2007). Hurricanes, in particular, can have severe impacts on energy infrastructure. In 2004, Hurricane Ivan destroyed seven Gulf of Mexico oil drilling platforms and damaged 102 pipelines, while Hurricanes Katrina and Rita in 2005 destroyed more than 100 platforms and damaged 558 pipelines (CCSP, 2007a). Though it is not possible to attribute the occurrence of any singular hurricane to climate change, projections of climate change suggest that extreme weather events are very likely to become more intense. If so, then the impacts of Katrina may be a possible indicator of the kinds of impacts that could manifest as a result of climate change (CCSP, 2007a).

In addition to the direct effects on operating facilities themselves, U.S. networks for transport, electric transmission, and delivery would be susceptible to changes due to climate change in streamflow, annual and seasonal precipitation patterns, storm severity, and even temperature increases (e.g., pipelines handling supercritical fluids may be impacted by greater heat loads) (CCSP, 2007a). It is not yet possible to project effects of climate change on the grid, because so many of the effects would be more localized than current climate change models can depict, but weather-related grid disturbances are recognized as a challenge for strategic planning and risk management (Karl et al., 2009).

A significant fraction of the U.S. energy infrastructure is located near the coasts. In these locations, rising sea levels are likely to lead to direct losses (e.g., equipment damage from flooding) as well as indirect effects such as the costs associated with raising vulnerable assets to higher levels. The U.S. East Coast and Gulf Coast have been identified as particularly vulnerable to sea level rise because the land is relatively low with respect to mean sea level and also sinking in many places (Karl et al., 2009).

U.S. rail transportation lines, which transport approximately two-thirds of the coal to the nation's power plants (CCSP, 2007a), often closely follow riverbeds. More severe rainstorms can lead to flooding of rivers which then can wash out or degrade the nearby roadbeds. Flooding may also disrupt the operation of inland waterways, the second-most important method of transporting coal. With utilities carrying smaller stockpiles and projections showing a growing reliance on coal for a majority of the nation's electricity production, any significant disruption to the transportation network has serious implications for the overall reliability of the grid as a whole (CCSP, 2007a).

In the Arctic, soil subsidence caused by the melting of permafrost is a risk to gas and oil pipelines, electrical transmission towers, and natural gas processing plants (Wilbanks et al., 2007). Along the Beaufort Sea in Alaska, climate impacts on oil and gas development in the region are likely to result in both financial benefits and costs in the future. For example, offshore oil exploration and production are likely to benefit from less extensive and thinner sea ice, although equipment will have to be designed to withstand increased wave forces and ice movement (ACIA, 2004).

13(c) Infrastructure and Settlements

Climate change vulnerabilities of industry, settlement, and society are mainly related to extreme weather events rather than to gradual climate change. The significance of gradual climate change (e.g., increases in the mean temperature) lies mainly in changes in the intensity and frequency of extreme events, although gradual changes can also be associated with thresholds beyond which impacts become significant, such as in the capacities of infrastructures (Field et al., 2007). Such climate-related thresholds for human settlements in the United States are currently not well understood (Wilbanks et al., 2008).

Extreme weather events could threaten U.S. coastal energy infrastructure and electricity transmission and distribution infrastructures. Moreover, soil subsidence caused by the melting of permafrost in the Arctic region is a risk to gas and oil pipelines, and electrical transmission towers. Vulnerabilities of industry, infrastructures, settlements, and society to climate change are generally greater in certain high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources, such as agricultural and forest product industries, water demands, and tourism. These vulnerabilities tend to be localized but are often large and growing (high confidence) (Wilbanks et al., 2007). Additionally, infrastructures are often connected, meaning that an impact on one can also affect others. For example, an interruption in energy supply can increase heat stress for vulnerable populations (Wilbanks et al., 2008). As noted previously, rising sea levels are likely to result in direct losses and indirect effects for the significant portion of the U.S. energy infrastructure located near the coasts (Karl et al., 2009).

A few studies have projected increasing vulnerability of U.S. infrastructure to extreme weather related to climate warming unless adaptation is effective (high confidence). Examples include the New York Metropolitan Region, the Mid-Atlantic Region, and the urban transportation network of the Boston metropolitan area (Wilbanks et al., 2007). In Alaska, examples where infrastructure is projected to be at "moderate to high hazard" in the mid-21st century include Shishmaref, Nome, Barrow, the Dalton Highway, and the Alaska Railroad (Field et al., 2007). Where extreme weather events become more

intense and/or more frequent with climate change, the economic and social costs of those events will increase (high confidence) (Wilbanks et al., 2007).

Buildings and Construction

In some Arctic areas, interactions between climate warming and inadequate engineering are causing problems. The weight of buildings on permafrost is an important factor; while many heavy, multi-story buildings of northern Russia have suffered structural failures, the lighter-weight buildings of North America have had fewer such problems as permafrost has warmed. Continuous repair and maintenance is also required for building on permafrost, a lesson learned because many of the buildings that failed were not properly maintained. The problems now being experienced in Russia may be expected to occur elsewhere in the Arctic if buildings are not designed and maintained to accommodate future warming (ACIA, 2004).

The cost of rehabilitating community infrastructure damaged by thawing permafrost could be significant. Even buildings designed specifically for permafrost environments may be subject to severe damage if design criteria are exceeded. The impervious nature of ice-rich permafrost has been relied on for contaminant-holding facilities, and thawing such areas could result in severe contamination of hydrological resources and large cleanup costs, even for relatively small spills (Anisimov et al., 2007). A significant number of Alaskan airstrips are built on permafrost and will require major repairs or relocation if their foundations are compromised by thawing. Overall, the cost of maintaining Alaska's public infrastructure is projected to increase by 10 to 20% by 2030 due to warming, costing the state an additional \$4 billion to \$6 billion, with roads and airports accounting for about half of this cost (Karl et al., 2009).

The construction season in the northern United States likely will lengthen with warming. In permafrost areas in Alaska, increasing the depth of the "active layer" or loss of permafrost can lead to substantial decreases in soil strength. Construction methods are likely to require changes in areas currently underlain by permafrost, potentially increasing construction and maintenance cost (high confidence) (Field et al., 2007).

Transportation

In a 2008 report entitled *Potential Impacts of Climate Change on U.S. Transportation*, the National Research Council (NRC) issued the following finding:

Climate change will affect transportation primarily through increases in several types of weather and climate extremes, such as very hot days; intense precipitation events; intense hurricanes; drought; and rising sea levels, coupled with storm surges and land subsidence. The impacts will vary by mode of transportation and region of the country, but they will be widespread and costly in both human and economic terms and will require significant changes in the planning, design, construction, operation, and maintenance of transportation systems (NRC, 2008).

NRC states that transportation infrastructure was designed for typical weather patterns, reflecting local climate and incorporating assumptions about a reasonable range of temperatures and precipitation levels (NRC, 2008). Stronger hurricanes would lead to a higher probability of such infrastructure failures as displacement of highway and rail bridge decks, or railroad tracks being washed away. The increase in heavy precipitation will cause increases in weather-related accidents, delays, and traffic disruptions in a network that is already being challenged by increasing congestion (Karl et al., 2009).

An increase in the frequency, intensity, or duration of heat spells in the United States and other world regions could cause railroad tracks to buckle and affect roads through softening and traffic-related rutting. Warmer or less snowy winters will likely reduce delays, improve ground and air transportation reliability, and decrease the need for winter road maintenance. More intense winter storms could, however, increase risk for traveler safety and require increased snow removal. Continuation of the declining fog trend in at least some parts of North America should benefit transport (Field et al., 2007).

Warming will likely affect infrastructure for surface transport at high northern latitudes, such as Alaska. Permafrost degradation reduces surface bearing capacity and potentially triggers landslides. While the season for transport by barge is likely to be extended, the season for ice roads will likely be compressed. Other types of roads are likely to incur costly improvements in design and construction (Field et al., 2007).

Similarly, NRC found the following:

Potentially, the greatest impact of climate change for North America's transportation systems will be flooding of coastal roads, railways, transit systems, and runways because of global rising sea levels, coupled with storm surges and exacerbated in some locations by land subsidence (NRC, 2008).

An example of this vulnerability lies in the fact that an estimated 60,000 miles (96,600 km) of coastal highway in the United States are already exposed to periodic flooding from coastal storms and high waves (Karl et al., 2009).

Because of warming, the number of days per year in which travel on the tundra is allowed under Alaska Department of Natural Resources standards has dropped from more than 200 to about 100 in the past 30 years, resulting in a 50% reduction in days that oil and gas exploration and extraction can occur (ACIA, 2004). Forestry is another industry in the Arctic region that requires frozen ground and rivers. Higher temperatures mean thinner ice on rivers and a longer period during which the ground is thawed. This leads to a shortened period during which timber can be moved from forests to sawmills and increasing problems associated with transporting wood (ACIA, 2004).

Lakes and river ice have historically provided major winter transportation routes and connections to smaller settlements in the Arctic. Reductions in ice thickness will reduce the load-bearing capacity, and shortening of the ice season will shorten period of access. Where an open-water network is viable, it will be sensible to increase reliance on water transport. In land-locked locations, construction of all-weather roads may be the only viable option, with implications for significantly increased costs. Similar issues will impact the use of sea ice roads primarily used to access offshore facilities (Anisimov et al., 2007). Loss of summer sea ice will bring an increasingly navigable Northwest Passage. Increased marine navigation and longer summers will improve conditions for tourism and travel associated with research (Anisimov et al., 2007). Along with rising water temperatures, however, increased shipping will also multiply the risk of marine pests and pollution (Anisimov et al., 2007). Sea ice reduction will likely increase erosion rates on land as well, thereby raising the maintenance costs for ports and other transportation infrastructure (Karl et al., 2009).

Negative impacts on transportation very likely will include coastal and riverine flooding and landslides. Although offset to some degree by fewer ice threats to navigation, reduced water depth in the Great Lakes would lead to "light loading" and adverse economic impacts (Field et al., 2007). A recent study found that the projected reduction in Great Lakes water levels would increase shipping costs for Canadian commercial navigation by an estimated 13 to 29% by 2050, all else remaining equal (Karl et al., 2009).

Of all the possible impacts on transportation, the greatest in terms of cost is that of flooding. The costs of delays and lost trips would be relatively small compared with damage to the infrastructure and to other property (Wilbanks et al., 2007).

The central Gulf Coast is particularly vulnerable to climate variability and change because of the frequency with which hurricanes strike, because much of its land is sinking relative to mean sea level and because much of its natural protection—in the form of barrier islands and wetlands—has been lost. While difficult to quantify, the loss of natural storm buffers will likely intensify many climate impacts, particularly in relation to storm damage (CCSP, 2008f).

Since much of the land in the Gulf Coast is sinking, this area is facing much higher increases in relative sea level rise (the combination of local land surface movement and change in mean sea level) than most other parts of the U.S. coast. A CCSP report found that relative sea level rise in the study area is very likely to increase by at least 12 inches (30 cm) across the region and possibly as much as 7 feet (2 m) in some parts of the study area over the next 50 to 100 years. The analysis of even a middle range of potential sea level rise of 12 to 35 inches (30 to 90 cm) indicates that a vast portion of the Gulf Coast from Houston to Mobile may be inundated in the future. The projected rate of relative sea level rise for the region during the next 50 to 100 years is consistent with historical trends, region-specific analyses, and the IPCC *Fourth Assessment Report* (IPCC, 2007a) findings, which assume no major changes in ice-sheet dynamics (CCSP, 2008f).

Twenty-seven percent of the major roads, 9% of the rail lines, and 72% of the ports in the region are at or below 48 inches (122 cm) in elevation, although portions of the infrastructure are guarded by protective structures such as levees and dikes. These protective structures could mitigate some impacts, but considerable land area is still at risk to permanent flooding from rising tides, sinking land, and erosion during storms. Furthermore, the crucial connectivity of the intermodal system in the area means that the services of the network can be threatened even if small segments are inundated (CCSP, 2008f).

A great deal of the Gulf Coast study area's infrastructure is subject to temporary flooding associated with storm surge. More than half of the area's major highways (64% of interstates, 57% of arterials), almost half of the rail miles, 29 airports, and virtually all of the ports are subject to flooding based on the study of a 18- and 23-foot (5.5- and 7.0-m) storm surge (CCSP, 2008f). The national importance of this area's transportation infrastructure is borne out by the fact that seven of the nation's 10 largest ports (by tons of traffic) are located along the Gulf Coast. Additionally, approximately two-thirds of U.S. oil imports are transported through this region (Karl et al., 2009).

Aviation may also be affected. Increases in precipitation and the frequency of severe weather events could negatively affect aviation. Higher temperatures affect aircraft performance and increase the necessary runway lengths. Some of these risks are expected to be offset by improvements in technology and information systems (CENR, 2008). Sea level rise and storm surge will increase the risk to coastal airports, and several of the nation's busiest airports that lie in coastal zones face the potential for closure or restrictions. Rising temperatures will affect airport ground facilities and runways similar to how roads will be affected. Airports in some areas will likely benefit through reduction in the cost of snow and ice removal and the impacts of salt and chemical use, though some locations have seen increases in snowfall (Karl et al., 2009).

Settlements

Since societies and their built environments have developed under a climate that has fluctuated within a relatively confined range of conditions, most impacts of a rapidly changing climate will present challenges. Society is especially vulnerable to extremes, many of which are increasing as climate changes. While there are likely to be some benefits and opportunities in the early stages of warming, negative impacts are projected to dominate as climate continues to change. Additionally, climate change impacts do not affect society in isolation but rather are exacerbated when combined with the effects of an aging and growing population, pollution, poverty, and natural environmental fluctuations (Karl et al., 2009).

According to the IPCC (2007b), “[t]he most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanization is occurring (high confidence). Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies (high confidence)”.

Effects of climate change on human settlements in the United States are very likely to vary considerably according to location-specific vulnerabilities, with the most vulnerable areas likely to include Alaska, flood-risk coastal zones and river basins, arid areas with associated water scarcity, and areas where the economic base is climate sensitive (CCSP, 2007a).

In Alaska and elsewhere in the Arctic, indigenous communities are facing major economic and cultural impacts. Many indigenous peoples depend on hunting polar bear, walrus, seals, and caribou, and herding reindeer, fishing and gathering, not only for food and to support the local economy but also as the basis for cultural and social identity. Changes in species’ ranges and availability, access to these species, a perceived reduction in weather predictability, and travel safety in changing ice and weather conditions present serious challenges to human health and food security, and possibly even the survival of some cultures (ACIA, 2004). More than 100 coastal villages in Alaska are subject to increased flooding and erosion due to warming (Karl et al., 2009).

More broadly, Native American communities possess unique vulnerabilities to climate change. Native Americans who live on established reservations are restricted to reservation boundaries and therefore have limited relocation options. Southwest native cultures are especially vulnerable to water quality and availability impacts (Karl et al., 2009).

Communities in risk-prone U.S. regions have reason to be particularly concerned about any potential increase in severe weather events. The combined effects of severe storms and sea level rise in coastal areas or increased risks of fire in drier arid areas are examples of how climate change may increase the magnitude of challenges already facing risk-prone communities. Vulnerabilities may be especially great for rapidly growing and/or larger metropolitan areas, where the potential magnitude of both impacts and coping requirements are likely to be very large. On the other hand, such regions have greater opportunity to put more adaptable infrastructure in place and make decisions that limit vulnerability (CCSP, 2007a).

Climate change has the potential not only to affect U.S. communities directly but also through undermining their economic bases. In particular, some regional economies are dependent on sectors highly sensitive to changes in climate: agriculture, forestry, water resources, or tourism. Climate change can add to stress on social and political structures by increasing management and budget requirements for public services such as public health care, disaster risk reduction, and even public safety. As sources of stress grow and combine, the resilience of social and political structures are expected to suffer, especially

in locales with relatively limited social and political capital (CCSP, 2007a). Additionally, as noted in Wilbanks et al. (2008), “[h]uman settlements are the foci for many economic, social, and governmental processes, and historical experience has shown that catastrophes in cities can have significant economic, financial, and political effects much more broadly.”

Within settlements experiencing climate change, certain parts of the population may be especially vulnerable. These include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. Environmental justice issues are clearly raised through examples such as warmer temperatures in urban areas having a more direct impact on those without air-conditioning (Wilbanks et al., 2008). Notably, vulnerable groups represent a more significant portion of the total population in some regions and localities than others (Karl et al., 2009).

More than 80% of the U.S. population currently resides in urban areas, which are becoming increasingly spread out, complex, and interconnected with regional and national economies and infrastructure. Climate-related changes will add further stress to an existing host of social problems that cities experience, including neighborhood degradation, traffic congestion, crime, unemployment, poverty, and inequities in health and well-being. Climate change impacts on cities are further compounded by aging infrastructure, buildings, and populations, as well as air pollution and population growth (Karl et al., 2009).

Finally, growth and development is generally moving toward areas more likely to be vulnerable to the effects of climate change. Overlaying projections of future climate change and its impacts on expected changes in U.S. population and development patterns reveals that more Americans will be living in the areas most vulnerable to climate change (Karl et al., 2009). For example, approximately half of the U.S. population—160 million people—were projected to live in one of 673 coastal counties by 2008. Coastal residents—particularly those on gently sloping coasts—should be concerned about sea level rise in the longer term, especially if these areas are subject to severe storms and storm surges and/or if their regions are showing gradual land subsidence. Areas that have been classified as highly vulnerable to climate change (based on measures of physical vulnerability and adaptive capacity) include counties lying along the East and West coasts and Great Lakes, with medium vulnerability counties mostly inland in the Southeast, Southwest, and Northeast (CCSP, 2007a).

Section 14

Ecosystems and Wildlife

This section of the document covers: 1) ecosystem and species-level impacts due to climate change and elevated CO₂ levels, 2) implications for ecosystem services, 3) how climate change effects on extreme event frequency and intensity may impact ecosystems, 4) implication for tribes, and 5) implications for tourism.

For North America, the IPCC (Field et al., 2007; Fischlin et al., 2007⁷⁴) concluded:

- Disturbances such as wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons (very high confidence).⁷⁵ Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services. Over the 21st century, changes in climate will cause species to shift north and to higher elevations and fundamentally rearrange North American ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

14(a) Ecosystems and Species

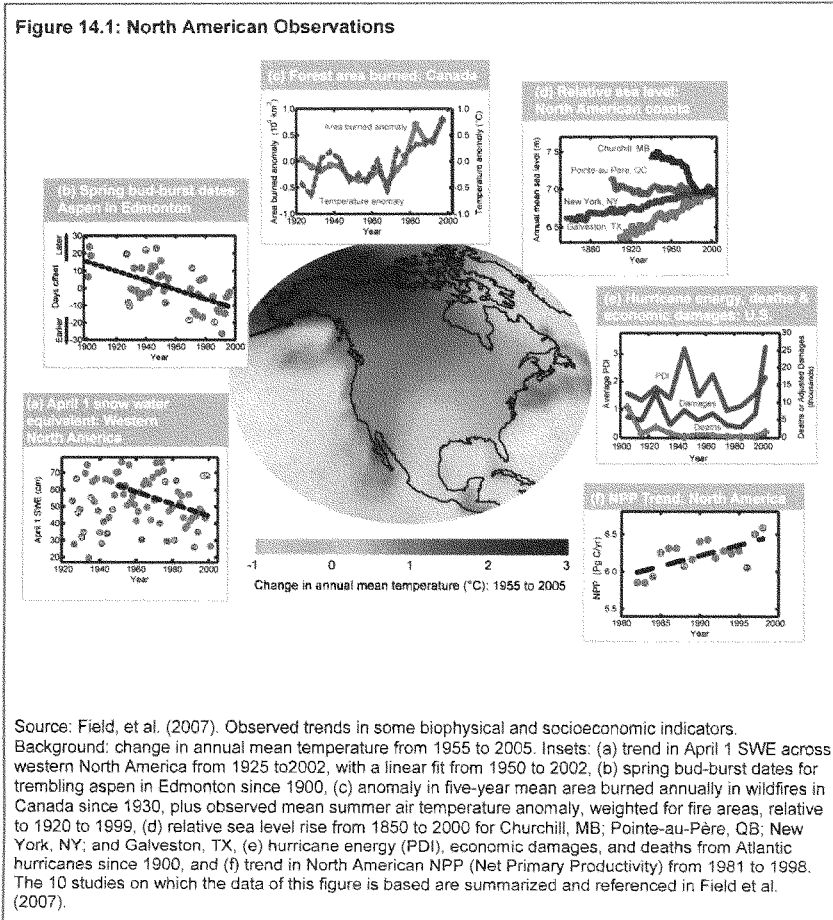
Ecosystems, plants, and animals are sensitive to climate variability and always have been. Three clearly observable connections between climate and terrestrial ecosystems are the seasonal timing of life cycle events (referred to as phenology), responses of plant growth or primary production, and the biogeographic distribution of species (see Figure 14.1). However, climate change effects on ecosystems do not occur in isolation. Ecosystems are increasingly being subjected to other human-induced pressures, such as land-use change, extractive use of goods, increasing degradation of natural habitats, air pollution, wildfires, and competition with invasives (Field et al., 2007; Fischlin et al., 2007). In the medium term (i.e., decades), climate change will increasingly exacerbate these human-induced pressures, causing a progressive decline in biodiversity (Fischlin et al., 2007).

The IPCC reviewed a number of studies describing observations of climate change effects on plant species (Field, et al., 2007 and references therein):

- Between 1981 and 2000, global daily satellite data indicate earlier onset of spring “greenness” by 10 to 14 days, particularly across temperate latitudes of the Northern Hemisphere. Field studies conducted in the same areas confirm these satellite observations.
 - Leaves are expanding earlier (e.g., apple and grape plants by two days per decade at 72 sites in Northeastern United States).
 - Flowering plants are blooming earlier (e.g., lilac by 1.8 days per decade earlier from 1959 to 1993, at 800 sites across North America; honeysuckle by 3.8 days per decade earlier in the western United States).

⁷⁴ Fischlin et al., 2007 citation refers to Chapter 4, “Ecosystems, Their Properties, Goods, and Services” in IPCC’s 2007 *Fourth Assessment Report*, Working Group II.

⁷⁵ According to IPCC terminology, “very high confidence” conveys a 9 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC’s uncertainty terms.



- The timing of autumn leaf senescence⁷⁶ across the continental United States, which is controlled by a combination of temperature, photoperiod, and water deficits, shows weaker trends.

The IPCC also discussed several studies showing how North American animals are responding to climate change, with effects on phenology, migration, reproduction, dormancy, and geographic range (Field, et al., 2007 and references therein):

- Warmer springs have led to earlier nesting for 28 migrating bird species on the East Coast of the United States and to earlier egg laying for Mexican jays and tree swallows.
- Several frog species now initiate breeding calls 10 to 13 days earlier than a century ago in the Upstate New York region.
- In lowland California, 16 of 23 butterfly species advanced the date of first spring flights an average 24 days over 31 years.
- Reduced water depth, related to recent warming, in Oregon lakes has increased exposure of toad eggs to ultraviolet (UV) radiation (UV-B), leading to increased mortality from a fungal parasite.
- The Edith's checkerspot butterfly has become locally extinct in the southern, low elevation portion of its western North American range, but has extended its range 56 mi (90 km) north and 394 feet (120 m) higher in elevation.

Changes in phenology vary between species, and the life cycles of plants, prey animals, and predators may shift out of sync, causing species to become decoupled from their resource requirements. For example, the decline of long-distance migratory birds in the United States may originate in mistiming of breeding and food abundance due to differences in phenological shifts in response to climate change (Scott et al., 2008). As warming drives changes in timing and geographic ranges for various species, it is important to note that entire communities of species do not shift intact (Karl et al., 2009). Many changes in phenology are occurring faster than the abilities of ecosystems and species to resist adverse impacts (Fischlin et al., 2007).

Many North American species, like the Edith's checkerspot butterfly, have shifted their ranges, typically to the north or to higher elevations (Field, et al., 2007). Migrating to higher elevations with more suitable temperatures can be an effective strategy for species if habitat connectivity⁷⁷ exists and other biotic and abiotic conditions are appropriate. However, many organisms cannot shift their ranges fast enough to keep up with the current pace of climate change (Fischlin et al., 2007). For example, migration rates of tree species from paleoecological records are on average 660 to 980 feet (200 to 300 m) yr⁻¹, which is significantly slower than what would be required to respond to anticipated climate change, which has been estimated to be greater than 0.6 mi (1 km) yr⁻¹ (Fischlin et al., 2007). In addition, species that require higher elevation habitat (e.g., alpine pikas), or assemblages for which no substrate may exist at higher latitudes (e.g., coral reefs), often have nowhere to migrate (Fischlin et al., 2007). Major changes have already been observed in alpine pika, as previously reported populations have disappeared entirely as climate has warmed over recent decades (Karl et al., 2009). Cold- and cool-water fisheries, especially salmonids, have been declining as warmer/drier conditions reduce their habitat (Field et al., 2007). The rates of changing conditions and the resulting habitat shifts, changes in phenology, and timing of migration generally have adverse effects on species, including decreased productivity and fitness (Fischlin et al., 2007).

⁷⁶ The term "senescence" is defined as the last stage of leaf development that includes changes in pigment expression, cell death, and eventual leaf drop.

⁷⁷ Connectivity is defined as the degree to which a habitat is physically linked with other suitable areas for a particular species.

The direct effects of elevated CO₂ concentrations and climate change to marine ecosystems include ocean warming, increased thermal stratification, reduced upwelling, sea level rise, increased wave height and frequency, loss of sea ice, and decreases in the pH and carbonate ion concentration of the surface oceans (see Box 14.1). With lower pH, aragonite (calcium carbonate) that is used by many organisms to make their shells or skeletons will decline or become undersaturated, affecting coral reefs and other marine calcifiers (e.g., pteropods-marine snails). Additional compounding effects, such as higher seawater temperatures leading to bleaching events, or higher seawater temperatures and nutrients leading to increased risk of diseases in marine biota will make these ecosystems even more vulnerable to changes in ocean chemistry along the United States and other world regions (Fischlin, et al., 2007). Subtropical and tropical coral reefs in shallow waters have already suffered major bleaching events that are clearly driven by increases in sea surface temperatures (Janetos et al., 2008). The effects of various other stressors, particularly human impacts such as overfishing, pollution, and the introduction of invasive species, appear to be exacerbating the thermal stresses on reef systems and, at least on a local scale, exceeding the thresholds beyond which coral is replaced by other organisms (Nicholls, et al., 2007). As a result of bleaching events and the subsequent disease outbreaks among those coral that survived the bleaching, approximately 50% of the corals in Virgin Islands National Park have died (Karl et al., 2009).

Box 14.1: Ocean Acidification Effects on Marine Calcifiers

Elevated atmospheric concentrations of GHGs impact the health of marine calcifiers by changing the physical and chemical properties of the oceans. Calcifiers play important roles in marine ecosystems by serving as the base of food chains, providing substrate, and helping to regulate biogeochemical cycles (Fischlin et al., 2007).

Ocean acidification lowers the saturation of calcium carbonate (CaCO₃) in sea water, making it more difficult for marine calcifiers to build shells and skeletons (Fischlin et al., 2007). The IPCC (Denman et al., 2007) made the following statements regarding ocean acidification:

- The biological production of corals, as well as calcifying phytoplankton and zooplankton within the water column, may be inhibited or slowed down as a result of ocean acidification;
- Cold-water corals are likely to show large reductions in geographic range this century.
- The dissolution of CaCO₃ at the ocean floor will be enhanced, making it difficult for benthic calcifiers to develop protective structures.
- Acidification can influence the marine food web at higher trophic levels.

The impacts of elevated CO₂ concentrations on oceanic chemistry will likely be greater at higher latitudes (Fischlin et al., 2007). Carbonate decreases at high latitudes and particularly in the Southern Ocean may have particularly adverse consequences for marine ecosystems because the current saturation horizon is closer to the surface than in other basins (Bindoff et al., 2007). Polar and sub-polar surface waters and the southern ocean are projected to be aragonite (a form of CaCO₃) under-saturated by 2100, and Arctic waters will be similarly threatened (Denman et al., 2007). These impacts will likely threaten ecosystem dynamics in these areas where marine calcifiers play dominant roles in the food web and in carbon cycling (Fischlin et al., 2007).

The overall reaction of marine biological carbon cycling and ecosystems to a warm and high-CO₂ world is not yet well understood. In addition, the response of marine biota to ocean acidification is not yet clear, both for the physiology of individual organisms and for ecosystem functioning as a whole (Denman et al., 2007).

In the Bering Sea along the Alaskan coast, rising air and sea water temperatures have caused reductions in sea ice cover and primary productivity in benthic ecosystems⁷⁸ (Anisimov et al., 2007). A change from Arctic to sub-Arctic conditions is happening with a northward movement of the pelagic-dominated marine ecosystem that was previously confined to the southeastern Bering Sea (Anisimov, et al., 2007).

⁷⁸ Benthic is defined as the deepest environment of a water body, which usually includes the seabed or lake floor.

Climate-related impacts observed in the Bering Sea include significant reductions in seabird and marine mammal populations, increases in pelagic fish, occurrences of previously rare algal blooms, abnormally high water temperatures, and smaller salmon runs in coastal rivers (ACIA, 2004). Plants and animals in polar regions are also vulnerable to attacks from pests and parasites that develop faster and are more prolific in warmer and moister conditions (Anisimov, et al., 2007). See Box 14.2 for more information on potential climate change impacts to polar bears.

Box 14.2: Polar Bears (adapted from Box 4.3 in Fischlin et al., 2007)

There are an estimated 20,000 to 25,000 polar bears (*Ursus maritimus*) worldwide, mostly inhabiting the annual sea ice over the continental shelves and inter-island archipelagos of the circumpolar Arctic. Polar bears are specialized predators that hunt ice-breeding seals and are therefore dependent on sea ice for survival. After emerging in spring from a five to seven month fast in nursing dens, females require immediate nourishment and thus, depend on close proximity between land and sea ice before the sea ice breaks up. Continuous access to sea ice allows bears to hunt throughout the year, but in areas where the sea ice melts completely each summer, they are forced to spend several months in tundra fasting on stored fat reserves until freeze-up (Fischlin et al., 2007).

Polar bears face great challenges from the effects of climatic warming, as projected reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals, and other animals (Fischlin, et al., 2007). The two Alaskan populations (Chukchi Sea: ~2,000 individuals in 1993, Southern Beaufort Seas: ~1,500 individuals in 2006) are vulnerable to large-scale dramatic seasonal fluctuations in ice movements because of the associated decreases in abundance and access to prey and increases in the energy costs of hunting (FWS, 2007). The IPCC projects that with a warming of 5°F (2.8°C) above pre-industrial temperatures and associated declines in sea ice, polar bears will face a high risk of extinction. Other ice-dependent species (e.g., walrus [for resting location]; small whales [for protection from predators]) face similar consequences, not only in the Arctic but also in the Antarctic (Fischlin et al., 2007).

In 2005, the World Conservation Union's (IUCN) Polar Bear Specialist Group concluded that the IUCN Red List classification for polar bears should be upgraded from *Least Concern* to *Vulnerable* based on the likelihood of an overall decline in the size of the total population of more than 30% within the next 35 to 50 years (Fischlin et al., 2007). In May 2008, the U.S. Fish and Wildlife Service listed the polar bear as a threatened species under the Endangered Species Act. This decision was based on scientific evidence showing that sea ice loss threatens, and will likely continue to threaten, polar bear habitat (FWS, 2008).

One consequence of longer and warmer growing seasons and less extreme cold in winter is that opportunities are created for many insect pests and disease pathogens to flourish. Accumulating evidence links the spread of some disease pathogens to a warming climate (Karl et al., 2009).

Ecosystem-Level Projections

For terrestrial ecosystems across all world regions, the IPCC concluded that substantial changes in structure and functioning of terrestrial ecosystems are very likely to occur with a global warming greater than 4 to 5°F (2 to 3°C) above pre-industrial levels (high confidence) (Fischlin, et al., 2007). Furthermore, changes in ecosystem structure and function, ecological interactions, and species' geographical ranges are projected to have predominantly negative consequences for biodiversity and the provisioning of ecosystem goods and services (IPCC, 2007b). Fischlin et al. (2007) concludes that ecosystems are expected to tolerate some level of future climate change and, in some form or another, will continue to persist, as they have done repeatedly with palaeoclimatic changes. A key issue, however, is whether ecosystem resilience⁷⁹ inferred from these responses will be sufficient to tolerate future

⁷⁹ Ecosystem resilience is the disturbance an ecosystem can tolerate before it shifts into a different state.

anthropogenic climate change (Fischlin et al., 2009). In North America, disturbances like wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons (very high confidence) (Field, et al., 2007).

At high latitudes, several models project longer growing seasons and increased net primary productivity (NPP) as a result of forest expansion into tundra ecosystems. In the mid-latitudes, simulated changes in NPP are variable, depending on whether there is sufficient enhancement of precipitation to offset increased evapotranspiration in a warmer climate. By the end of the 21st century, ecosystems in the northeast and southeast United States are projected to become carbon sources, while the western United States remains a carbon sink (Field, et al., 2007). Figure 14.1 shows the observed NPP trend in North America between 1981 and 1998.

The areal extent of drought-limited ecosystems is projected to increase 11% per degree celsius warming in the continental United States. Climate change and direct human land-use pressures are both likely to have adverse impacts on desert ecosystems and species. Increases in plant productivity resulting from the direct effects of rising atmospheric CO₂ concentrations may partially offset these adverse effects. In California, temperature increases greater than 4°F (2°C) may lead to the conversion of shrubland into desert and grassland ecosystems and evergreen conifer forests into mixed deciduous forests (Fischlin, et al., 2007). Climate models suggest a warmer, drier future climate for the Prairie Pothole Region, which would result in a reduction in, or elimination of, wetlands that provide waterfowl breeding habitat (CCSP, 2009d). These types of regional impacts are indicative of the kinds of changes that can be expected across large parts of the country.

The sea ice biome accounts for a large proportion of primary production in polar waters and supports a substantial food web. In the Northern Hemisphere, projections of ocean biological response to climate warming by 2050 show contraction of the highly productive marginal sea ice biome by 42% (Fischlin, et al., 2007). In the Bering Sea, primary productivity in surface waters is projected to increase, the ranges of some cold-water species will shift north, and ice-dwelling species (e.g., polar bears and walrus) will experience habitat loss (ACIA, 2004).

Species-Level Projections

After reviewing studies on the projected impacts of climate change on species, IPCC concluded that on a global scale (Fischlin et al., 2007 and references therein):

- Projected impacts on biodiversity are significant and of key relevance, since global losses in biodiversity are irreversible (very high confidence).
- Endemic species⁸⁰ richness is highest where regional palaeoclimatic changes have been subtle, providing circumstantial evidence of their vulnerability to projected climate change (medium confidence). With global average temperature changes of 4°F (2°C) above pre-industrial levels, many terrestrial, freshwater, and marine species (particularly endemics across the globe) are at a far greater risk of extinction than in the geological past (medium confidence).
- Approximately 20 to 30% of species (global uncertainty range from 10 to 40%, but varying among regional biota from as low as 1% to as high as 80%) will be at increasingly high risk of extinction by 2100.

In North America, climate change impacts on inland aquatic ecosystems will range from the direct effects of increased temperature and CO₂ concentration to indirect effects associated with alterations in

⁸⁰ Endemic species are unique to their location or region and are not found anywhere else on Earth.

hydrological systems resulting from changes to precipitation regimes and melting glaciers and snow pack (Fischlin et al., 2007). For many freshwater animals, such as amphibians, migration to breeding ponds and the production of eggs is intimately tied to temperature and moisture availability. Asynchronous timing of breeding cycles and pond drying due to the lack of precipitation can lead to reproductive failure. Differential responses among species in arrival or persistence in ponds will likely lead to changes in community composition and nutrient flow in ponds (Fischlin et al., 2007). Many warm-water and cool-water (freshwater) fish species will shift their ranges northward and to higher altitudes. In the continental United States, cold-water species will likely disappear from all but the deeper lakes, cool-water species will be lost mainly from shallow lakes, and warm water species will thrive except in the far South, where temperatures in shallow lakes will exceed survival thresholds (Field et al., 2007). See also Section 9(f) for a discussion of climate change impacts to freshwater and marine fish populations.

Bioclimate modeling based on output from five general circulation models (GCMs) suggests that on the long (millennial) timescale there may be decreases of bird and mammal species richness in warmer, low elevation areas, but increases in cold high elevation zones, and increases of reptile species richness in all areas. IPCC found that climate change impacts will vary regionally and across biomes and will lead to increasing levels of global biodiversity loss, as expressed through area reductions of wild habitats and declines in the abundance of wild species, putting those species at risk of extinction. Overall, climate change has been estimated to be a major driver of biodiversity loss in cool conifer forests, savannas, mediterranean-climate systems, tropical forests, in the Arctic tundra, and in coral reefs (Fischlin et al., 2007). In the United States, some common forests types are projected to expand, such as oak-hickory; others are projected to contract, such as maple-beech-birch. Still others, such as spruce-fir, are likely to disappear from the contiguous United States (Karl et al., 2009). Changes in plant species composition in response to climate change can increase ecosystem vulnerability to other disturbances, including fire and biological invasion. There are other possible, and even probable, impacts and changes in biodiversity-related relationships (e.g., disruption of the interactions between pollinators, such as bees, and flowering plants), for which there is not a substantial observational database (Janetos et al., 2008).

On small oceanic islands with cloud forests or high elevation ecosystems, such as the Hawaiian Islands, extreme elevation gradients exist, ranging from nearly tropical to alpine environments. In these ecosystems, anthropogenic climate change, land-use changes, and biological invasions will work synergistically to drive several species (e.g., endemic birds) to extinction (Mimura et al., 2007).

Coastal waters in the United States are very likely to continue to warm. In the Northeast, water temperatures may increase by as much 4 to 8°F (2 to 4°C) in this century, both in summer and winter. This will result in a northward shift in the geographic distribution of marine life along the coasts, which is already being observed in some areas. The shift occurs because some species cannot tolerate the higher temperatures and others are outcompeted by species moving in from more southerly locations. Warming also opens the door to invasion by species that humans are intentionally or unintentionally transporting around the world, for example in the ballast water carried by ships. Species that were previously unable to establish populations because of cold winters are likely to find the warmer conditions more suitable and gain a foothold, particularly as native species are under stress from climate change and other human activities. Non-native clams and small crustaceans have already had major effects on the San Francisco Bay ecosystem and the health of its fishery resources (Karl et al., 2009).

According to the IPCC, climate change (very high confidence) and ocean acidification (see Box 14.1) due to the direct effects of elevated CO₂ concentrations (medium confidence) will impair a wide range of planktonic and other marine organisms that use aragonite to make their shells or skeletons (Fischlin et al., 2007). Average pH for the ocean surface is projected to decrease by up to 0.3 to 0.4 units by 2100 (Fischlin et al., 2007). These impacts could result in potentially severe ecological changes to tropical and coldwater marine ecosystems where carbonate-based phytoplankton and corals are the foundation for the

trophic system (Schneider et al., 2007). Calcification rates in aragonitic corals may decline by 20 to 60% under a doubling of atmospheric CO₂ concentrations, with erosion outpacing reef formation at even lower concentrations (Fischlin et al., 2007). The IPCC concluded that it is very likely that a projected future sea surface temperature increase of 2 to 5°F (1 to 3°C) will result in more frequent bleaching events and widespread mortality, if there is not thermal adaptation or acclimatization by corals and their algal symbionts (Nicholls et al., 2007). The ability of coral reef ecosystems to withstand the impacts of climate change will depend to a large degree on the extent of degradation from other anthropogenic pressures (Nicholls et al., 2007). Furthermore, the migration of corals to higher latitudes with more optimal sea surface temperatures is unlikely, due to latitudinally decreasing aragonite concentrations, projected acidification from increasing CO₂ in the atmosphere, and the lack of available substrate (Fischlin et al., 2007).

For the Arctic, the IPCC (Anisimov et al., 2007 and references therein) concluded that:

- Decreases in the abundance of keystone species⁸¹ are expected to be the primary factor in causing ecological cascades⁸² and other changes to ecological dynamics.
- Arctic animals are likely to be most vulnerable to warming-induced drying of small water bodies; changes in snow cover and freeze-thaw cycles that affect access to food (e.g., polar bear dependence on sea ice for seal hunting; see Box 14.2) and protection from predators (e.g., snow rabbit camouflage in snow); changes that affect the timing of behavior (e.g., migration and reproduction); and influx of new competitors, predators, parasites, and diseases.
- In the past, sub-arctic species have been unable to live at higher latitudes because of harsh conditions. Climate-change-induced warming will increase the rate at which sub-arctic species are able to establish. Some non-native species, such as the North American mink, will become invasive, while other species that have already colonized some Arctic areas are likely to expand into other regions. The spread of non-native, invasive plants will likely have adverse impacts on native plant species. For example, experimental warming and nutrient addition has shown that native mosses and lichens become less abundant when non-native plant biomass increases.
- Bird migration routes and timing are likely to change as the availability of suitable habitat in the Arctic decreases.
- Loss of sea ice will impact species, such as harp seals, which are dependent on it for survival.
- Climate warming is likely to increase the incidence of pests, parasites, and diseases such as musk ox lung worm and abomasal nematodes of reindeer.

14(b) Ecosystem Services

Ecosystems provide many goods and services that are of vital importance for biosphere function and provide the basis for the delivery of tangible benefits to humans. These services include: maintenance of biodiversity, nutrient regulation, shoreline protection, food and habitat provisioning, sediment control, carbon sequestration, regulation of the water cycle and water quality, protection of human health, and the production of raw materials (Fischlin et al., 2007). Climate change is projected to have an increasing effect on the provisioning of ecosystem services in the United States. Increasing temperatures and shifting precipitation patterns, along with the direct effects of elevated CO₂ concentrations, sea level rise, and changes in climatic variability, will affect the quantity and quality of these services. By the end of the

⁸¹ Keystone species are species that have a disproportionate effect on their environment relative to their abundance or total biomass. Typically, ecosystems experience dramatic changes with the removal of such species.

⁸² Ecological cascades are defined as sequential chains of ecological effects, including starvation and death, beginning at the bottom levels of the food chain and ascending to higher levels, including apex predators.

21st century, climate change and its impacts may be the dominant driver of biodiversity loss and changes in ecosystem services globally (Millennium Ecosystem Assessment-Synthesis, 2005).

Many U.S. ecosystems and the services they provide are already threatened by natural and anthropogenic non-climate stressors. Climate-related effects on ecosystems services will amplify the effects of non-climate stressors. Multiple U.S. industries, such as timber, fisheries, travel, tourism, and agriculture that are already threatened could face substantially greater impacts with concurrent effects on financial markets (Ryan et al., 2008; Field et al., 2007).

14(c) Extreme Events

Many significant impacts of climate change on U.S. ecosystems and wildlife may emerge through changes in the intensity and the frequency of extreme weather events. Extreme events, such as hurricanes, can cause mass mortality in wildlife populations and contribute significantly to alterations in species distribution and abundance following the disturbance. For example, the aftermath of a hurricane can cause coastal forest to die from storm surge-induced salt deposition, leading to habitat loss. More intense hurricanes may therefore increase coastal flooding resulting in a larger extent of forest dieback (Karl et al., 2009).

Droughts play an important role in forest dynamics as well, causing pulses of tree mortality in the North American woodlands. Greater intensity and frequency of extreme events may alter disturbance regimes in North American coastal ecosystems leading to changes in diversity and ecosystem functioning (Field et al., 2007; Fischlin et al., 2007). Species inhabiting saltmarshes, mangroves, and coral reefs are likely to be particularly vulnerable to these effects (Fischlin et al., 2007). Higher temperatures, increased drought, and more intense thunderstorms will very likely increase erosion and promote invasion of exotic grass species in arid lands (Ryan et al., 2008).

14(d) Implications for Tribes

North American indigenous communities whose health, economic well-being, and cultural traditions depend upon the natural environment will likely be affected by the degradation of ecosystem goods and services associated with climate change (Field et al., 2007). Among the most climate-sensitive North American communities are those of indigenous populations dependent on one or a few natural resources. About 1.2 million (60%) of U.S. tribal members live on or near reservations, and many pursue lifestyles with a mix of traditional subsistence activities and wage labor (Field et al., 2007).

In Alaska and elsewhere in the Arctic, indigenous communities are facing major economic and cultural impacts. Many indigenous peoples depend on hunting polar bear, walrus, seals, and caribou, and herding reindeer, fishing and gathering, not only for food and to support the local economy, but also as the basis for cultural and social identity. These livelihoods are already being threatened by multiple climate-related factors, including reduced or displaced populations of marine mammals, caribou, seabirds, and other wildlife; losses of forest resources due to insect damage; and reduced/thinner sea ice, making hunting more difficult and dangerous (ACIA, 2004).

14(e) Implications for Tourism

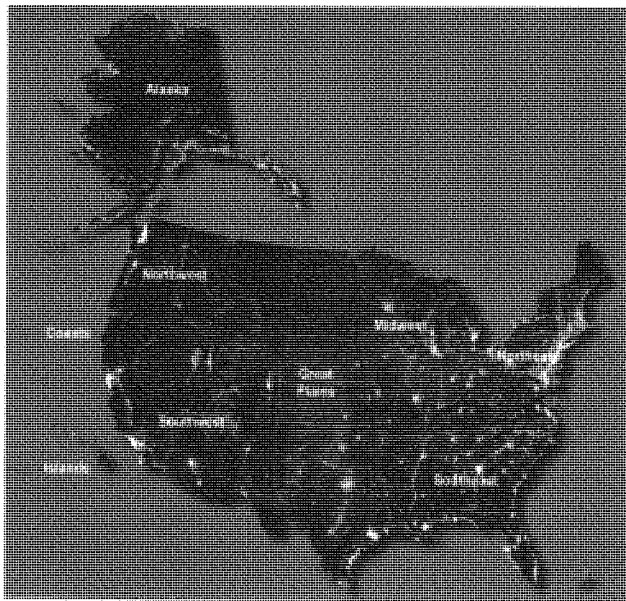
The United States ranks among the top 10 nations for international tourism receipts (US\$112 billion), with domestic tourism and outdoor recreation markets that are several times larger than most other countries. Nature-based tourism is a major market segment in North America, with more than 900 million visitor-days in national/provincial/state parks in 2001. Climate variability affects many segments of this growing economic sector. For example, wildfires in Colorado (2002) caused tens of millions of dollars in tourism losses by reducing visitation and destroying infrastructure. Similar economic losses during that same year were caused by drought-affected water levels in rivers and reservoirs in the western United States and parts of the Great Lakes. The 10-day closure and clean-up following Hurricane Georges (September 1998) resulted in tourism revenue losses of approximately \$32 million in the Florida Keys. While the North American tourism industry acknowledges the important influence of climate, its impacts have not been analyzed comprehensively (Field et al., 2007 and references therein).

Section 15

U.S. Regional Climate Change Impacts

This section summarizes the present and future impacts of climate change on the different regions of the United States. The information presented here is taken from a recent report by the USGCRP entitled *Global Climate Change Impacts in the United States* (Karl et al., 2009), which includes key conclusions from all 21 CCSP synthesis and assessment products. All of the information presented in this section derives from this comprehensive assessment report. The discussion of impacts is divided into the nine regions used in Karl et al., (2009): Northeast, Southeast, Midwest, Great Plains, Southwest, Northwest, Alaska, and Islands (Figure 15.1). Information about observed trends as well as projected impacts is provided. In some cases, a range of potential future impacts is described, reflecting lower and higher emissions scenarios.⁸³

Figure 15.1: Map of U.S. Regions Discussed in USGCRP



Source: Karl et al. (2009). This section summarizes key climate change impacts on specific regions of the United States.

⁸³ Karl et al. (2009) use “lower emission scenario” to refer to the IPCC SRES B1 and “higher emission scenario” to refer to A2. The SRES emission scenarios are described in Section 6(a).

15(a) Northeast

According to studies cited in Karl et al. (2009), the annual average temperature in the Northeast has increased by 2°F (1°C) (relative to a 1960-1979 base period) since 1970; winter temperatures have risen by 4°F (2°C); and there are more frequent days with temperatures above 90°F (32°C). Temperatures in the Northeast are projected to rise an additional 2.5 to 4°F (1.4 to 2°C) in winter and 1.4 to 3.4°F (0.78 to 1.9°C) in summer over the next several decades (across low and high emissions scenarios). Precipitation changes are likely⁸⁴ to include an increase in heavy rainfall events and less winter precipitation falling as snow and more as rain.

Water and Coastal Resources

Given the anticipated changes in temperature and precipitation, the Northeast is likely to experience reduced snowpack in the mountains, earlier breakup of winter ice on lakes and rivers, and earlier spring snowmelt resulting in earlier peak river flows. These projected changes in regional hydrology would impact summer water storage and availability, and could cause short-term (one- to three-month) droughts to occur as frequently as once each summer across the New England states and in the Catskill and Adirondack Mountains.

The densely populated coasts of the Northeast are particularly vulnerable to sea level rise, which is projected to rise more than the global average and increase the frequency and severity of damaging storm surges, coastal flooding, and related impacts like erosion, property damage, and loss of wetlands. New York State alone has more than \$2.3 trillion in insured coastal property, but some major insurance companies are beginning to withdraw coverage in coastal areas of the Northeast, including New York City. A coastal flood in New York City currently considered a once-in-a-century event (also known as a 100-year flood) is projected to occur every 10 to 22 years on average by late this century, depending on a higher or lower emissions scenario.

Human Health

Rising temperatures will impact human health, particularly among vulnerable populations like children, the elderly, and the economically disadvantaged. Under a high-emissions scenario, hot summer conditions are projected to arrive three weeks earlier and last three weeks longer into the fall by late this century. Cities that presently experience on average few days over 100°F (38°C) each summer would experience 20 such days on average by late this century. Certain cities such as Hartford and Philadelphia would average nearly 30 days over 100°F (38°C) (under a high emissions scenario). Heat waves are currently rare in the Northeast but are likely to become much more commonplace. In addition, the number of days that fail to meet federal air quality standards is projected to increase with rising temperatures if there are no additional controls on ozone-causing pollutants.

Key Economic Sectors

Rising temperatures will extend the growing season for the region's agriculture, but are also likely to make large areas unsuitable for growing apples, blueberries, and cranberries typical of the Northeast. The maple-beech-birch forests of the Northeast are projected to shift dramatically northward as temperatures rise, affecting the viability of maple sugar businesses. An important agricultural sector in the Northeast—the dairy industry—is projected to experience a 10 to 20% decline in milk production by the end of the

⁸⁴ Kart et al. (2009) use the term “likely” to reflect at least a two-thirds chance of occurring and “very likely” to reflect at least a 90% chance of occurring.

century in the southern parts of the region. Winter recreation industries including downhill and cross-country skiing and snowshoeing will be adversely affected by the projected decline in snow cover. The region's lobster and cod fishing industry may also be impacted by rising ocean temperatures and subsequent northward shift of species in search of cooler waters.

15(b) Southeast

The annual average temperature in the Southeast has risen about 2°F (1°C) since 1970, with the greatest seasonal increase in winter (Karl et al., 2009). On average, there have been four to seven fewer freezing days per year for most of the region since the mid-1970s. Under a lower future emissions scenario, average temperatures in the region are projected to rise by about 4.5°F (2.5°C) by the 2080s. Under a higher emissions scenario, climate models project a temperature increase of 9°F (5°C) on average, with about a 10°F (5.8°C) increase in summer. Current precipitation trends indicate an increase in autumn rainfall in some parts of the region. Winter and spring rainfall is projected to decline across most of the Southeast, with greater reductions expected in Gulf Coast states compared with the more northern states in the region.

Water and Coastal Resources

The extent of the region experiencing moderate to severe spring and summer drought has increased by 12% and 14%, respectively, since the mid-1970s. The future frequency, duration, and intensity of droughts are likely to increase. Increasing evaporation and plant water loss rates could affect the amount of runoff and groundwater recharge, which would likely lead to saltwater intrusion into shallow aquifers in many parts of the Southeast. Any increase in groundwater pumping would further stress or deplete aquifers, which could in turn place additional strain on surface water resources.

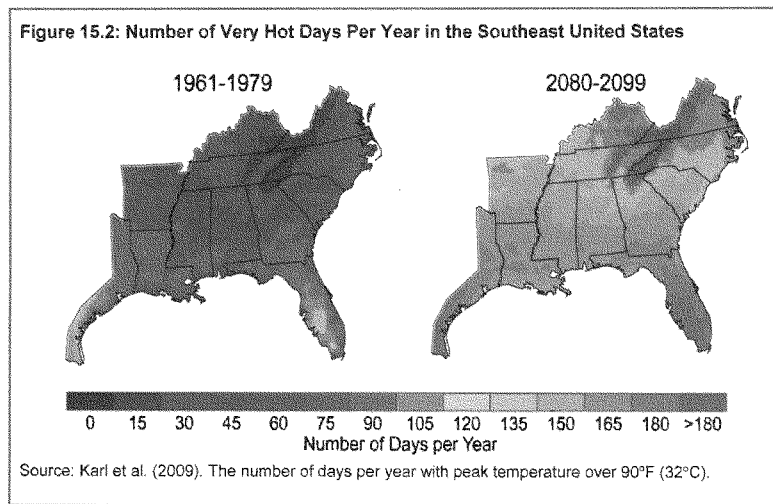
Major hurricanes already pose a severe risk to people, personal property, and public infrastructure in the Southeast, particularly in low-lying coastal ecosystems and coastal communities along the Gulf and South Atlantic coasts. The intensity of Atlantic hurricanes has increased since 1970, correlated with an increase in ocean surface temperature; however, a similar correlation has not been established for the frequency of hurricanes making landfall. The intensity of Atlantic hurricanes is likely to increase during this century with higher peak wind speeds, rainfall intensity, and storm surge height and strength. Even with no increase in hurricane intensity, more frequent storm surge flooding, shoreline retreat, and permanent inundation of coastal ecosystems and communities is likely. An increase in average sea level of up to 24 inches (60 cm) or more is projected for the Southeast, with greatest impact expected in low-lying areas such as those along the central Gulf Coast where the land surface is sinking.

Human Health and Ecosystems

Climate changes and associated impacts projected to occur in the Southeast, including increases in water scarcity, sea level rise, extreme weather events, and heat stress, have implications for health and quality of life. The number of very hot days is projected to rise at a greater rate than the average temperature (Figure 15.2), and both heat stress and heat-stress related deaths in the summer months are likely to increase. While fewer cold-related deaths are expected, this is not expected to offset the increase in heat-related deaths.

Ecosystem impacts from projected temperature increases may include altered distribution of native plants and animals; local extinction of many threatened and endangered species; displacement of native species by invasive species; more frequent and intense wildfires, forest pest outbreaks (such as the southern pine beetle); and loss of lakes, ponds, and wetlands from intense droughts. Sea level rise and associated

impacts are also likely to increase the salinity of estuaries, coastal wetlands, and tidal rivers. Salinity changes may reduce viable habitat and displace native plant and animal species farther inland (if no migration barriers exist).



Key Economic Sectors

The Southeast's projected rate of warming over the next 50 to 100 years would contribute to heat-related stress for trees and crop species. Warmer water temperatures reduce dissolved oxygen in stream, lakes, and shallow aquatic habitats, potentially leading to fish kills and negatively impacting the region's fisheries. Beef cattle production is negatively affected at continuous temperatures in the 90 to 100°F (32 to 38°C) range; cattle and other rangeland livestock may also experience significant production declines. Although the poultry and swine industries primarily use indoor operations, projected temperature increases could significantly increase energy requirements.

15(c) Midwest

In recent decades, an increase in average temperatures in the Midwest has been observed despite the strong year-to-year variations (Karl et al., 2009). The greatest increase has been measured in winter, reducing lake ice and extending the length of the frost-free or growing season by more than one week. Heat waves have been more frequent in the Midwest in the last three decades than any time in the last century outside of the Dust Bowl years of the 1930s. Climate models indicate that summer average temperature in Illinois and Michigan is expected to feel progressively more like summers currently experienced in the southeastern states. The last three decades have been the wettest period in a century, with above average summer and winter precipitation. Precipitation in the Midwest is projected to increase in winter and spring, but decrease in summer in some parts of the region. Heavy downpours are

now twice as frequent as they were a century ago, and the intensity of rainfall events is also expected to increase in the future.

Human Health

Rising temperatures will increase the frequency of hot days as well as the frequency, severity, and duration of heat waves in the Midwest. Warmer air temperatures, more stagnant air, and more emissions from vegetation could contribute to increased ground-level ozone (a component of smog) and affect air quality throughout the region unless the emissions of ozone-forming pollutants are significantly reduced. Increased tick and mosquito survival during warmer winters may contribute to the spread of diseases like West Nile virus. Warmer water temperatures may increase the risk of waterborne diseases as many pathogens thrive in warmer conditions. The projected increase in heavy downpours may overload drainage systems and water treatment facilities, which can result in beach closures to reduce the risk of disease transmission. Additionally, warmer water and low-oxygen conditions can more readily mobilize mercury and other persistent pollutants in contaminated lake sediment. These contaminants can then be taken up in the aquatic food chain, increasing the health risks for humans and wildlife that eat fish from the lakes. Expected positive benefits of warming include improved traffic safety due to fewer days with snow on the ground and decreased heating oil demand.

Water Resources and Ecosystems

Projected increases in evaporation rates and longer periods between rainfalls in the summer may decrease ground water recharge and surface water flows, and increase the likelihood of drought in the Midwest. Water levels in rivers, streams, lakes, and wetlands are likely to decline, which may degrade aquatic and wetland habitat for native plants and animals. Water levels in the Great Lakes are projected to fall up to 12 inches (30 cm) by the end of the century under a lower emissions scenario and between 12 and 24 inches (30 and 60 cm) under a higher emissions scenario. In some lakes, warming water temperatures also contribute to the creation of oxygen-poor or oxygen-free "dead zones" that kill fish and other species. Populations of cold-water fish, such as brook trout, lake trout, and whitefish, are expected to decline dramatically while cool-water and warm-water fish such as muskie, smallmouth bass, and bluegill would benefit from warmer water temperatures. Non-native and invasive aquatic species, which tend to thrive under a wide range of environmental conditions, may displace native species that are adapted to a narrower range of conditions.

In response to warming temperatures, plants native to the Southeast are likely to shift their ranges northward and become established throughout the Midwest by the end of the century. The ability of plants and animals native to the Midwest to shift their ranges northward to keep pace with the changing climate will be inhibited by migration barriers such as major urban areas and the Great Lakes. Likely climate change impacts on forests include both the positive effects of higher CO₂ and nitrogen levels acting as fertilizers as well as the negative effects of decreasing air quality, more frequent droughts and wildfire hazards, and an increase in insect pests like gypsy moths.

Regional Infrastructure and Economy

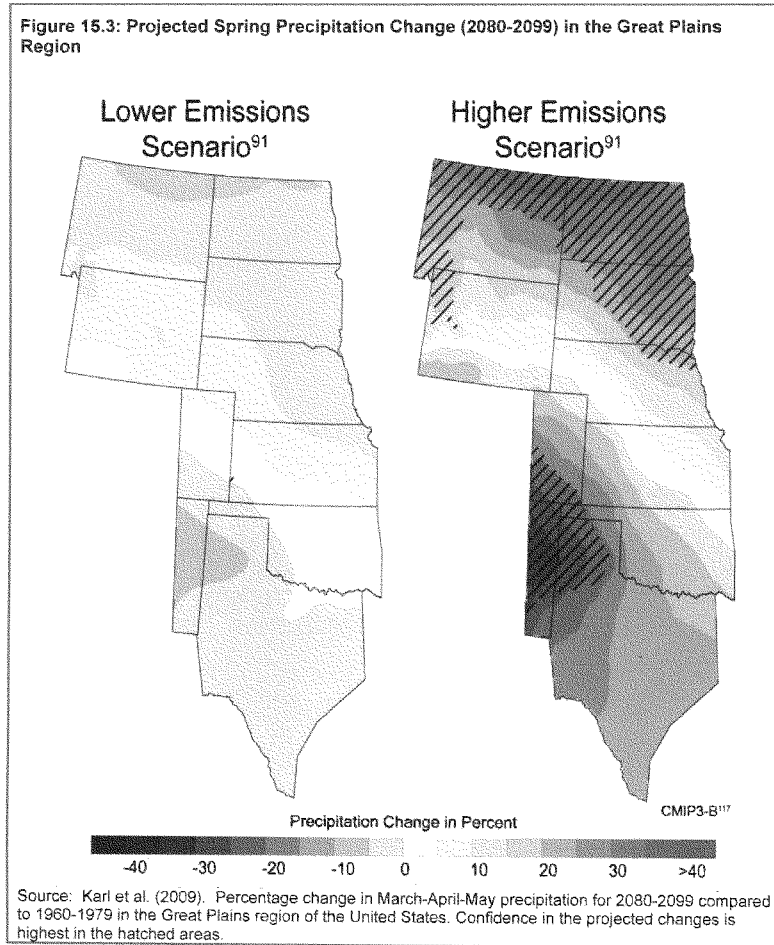
The Midwest has experienced two record-breaking floods in the past 15 years, and this trend is expected to continue given projected future increases in winter and spring precipitation combined with greater frequency of heavy downpours. More frequent flooding is likely to cause increased property damage, insurance rates, emergency management costs, and clean-up and rebuilding costs. High electricity demand for air conditioning during heat waves may stress energy production systems and increase the likelihood of electricity shortages, brownouts, and blackouts. Positive benefits of rising temperatures include a decreased demand for heating oil and gas in the winter. Projected reductions in water levels in the Great Lakes and Mississippi and Missouri river systems may impact and increase costs associated with dredging, infrastructure, river barge traffic, and shipping (low water levels reduce a ship's ability to carry freight). Climate change impacts on agriculture include both the positive effects of longer growing seasons and CO₂ fertilization as well as the negative effects of increased flooding, disease-causing pathogens, insect pests, and weeds. The livestock industry is expected to face higher costs as higher temperatures stress livestock and decrease production.

15(d) Great Plains

Studies cited by Karl et al. (2009) indicate that average temperatures in the Great Plains region have increased approximately 1.4°F (0.78°C) relative to a 1960s and 1970s baseline, with the largest changes occurring in winter months and over the northern states. Relatively cold days are becoming less frequent and relatively hot days more frequent. By the end of the century, temperatures are projected to continue to increase by 2.5°F (1.4°C) to more than 13°F (7.2°C) compared with the 1960 to 1979 baseline, depending on future emissions. Summer warming is projected to be greater than that in winter throughout the southern and central Great Plains. Increased spring precipitation and overall wetter conditions are expected in the northern part of the region, while the South is projected to experience decreased spring precipitation and overall drier conditions by the end of the century (Figure 15.3).

Water Resources

The High Plains aquifer (sometimes called the Ogallala aquifer, after its largest formation) stretches from South Dakota to Texas and supplies the Great Plains with most of its drinking and irrigation water. Current water use on the Great Plains is unsustainable, with more water withdrawn (19 billion gallons daily on average) than the rate of recharge. Projected changes including increasing temperatures, faster evaporation rates, and more sustained droughts will further stress the region's ground water resources. The region will likely be challenged with supplying water for agriculture, ranching, and the region's rapidly growing cities. The largest effects are expected in heavily irrigated areas in the southern Great Plains, already experiencing unsustainable water use and greater frequency of extreme heat.



Ecosystems

Changes in temperature and precipitation affect the composition and diversity of native animals and plants by altering their breeding patterns, water and food supply, and habitat availability. Climate-driven changes combined with other human-induced stresses are likely to further increase the vulnerability of ecosystems to pests, invasive species, and loss of native species. Some pest populations such as red fire ants and rodents are projected to increase because they are better adapted to a warmer climate. Key

ecosystems like grasslands and wetlands are already threatened by urban sprawl and certain agriculture and ranching practices and may be further impacted by future heat and water stress. These ecosystems provide crucial habitat for grassland and plains birds, migratory waterfowl and shorebirds, and some threatened and endangered species, all of which may experience significant shifts and reductions in their ranges as a result of climate change.

Regional Economy and Human Health

As temperatures increase over this century, agriculture will be affected as optimal areas for growing particular crops shift. Insect pests that were historically unable to survive in the Great Plains' cooler areas are expected to increase in population and spread northward. Rising CO₂ levels in the atmosphere can increase crop growth, but also make some types of weeds grow even faster. Projected precipitation increases in the northern Great Plains are unlikely to be sufficient to offset decreasing soil moisture and aquifer depletion. Some areas are expected to be unable to sustain even current agricultural usage given projections of future water supply.

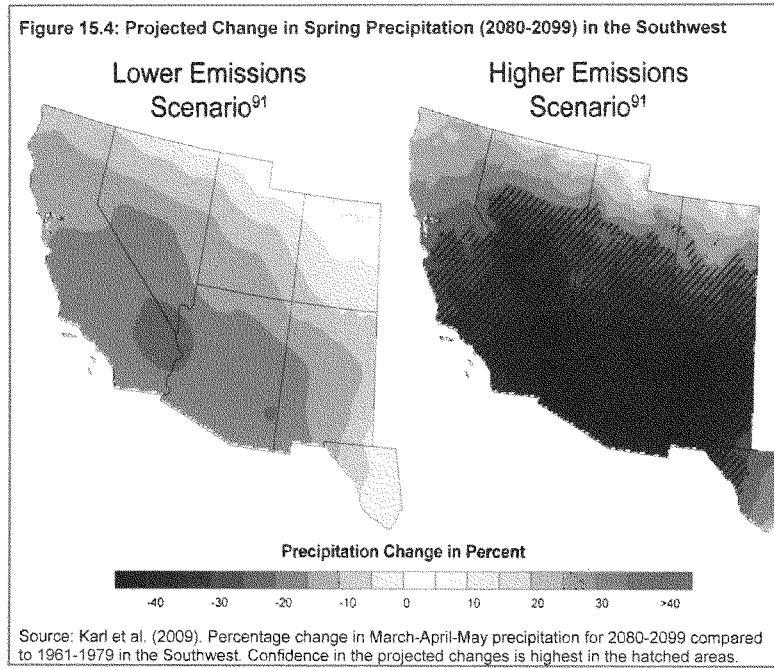
Many rural areas in the Great Plains region have relatively large populations of very old and very young people, who are at greater risk of health impacts from climate change. Urban populations, particularly the young, elderly, and economically disadvantaged, may also be disproportionately affected by heat.

15(e) Southwest

According to studies cited in Karl et al. (2009), the average annual temperature in the Southwest has increased 1.4°F (0.78°C) compared to a 1960–1979 baseline. Average annual temperature across the region is projected to rise approximately 4°F to 10°F (2 to 5.6°C) above the historical baseline by the end of the century, depending on emissions scenarios. Summer temperature increases are projected to be greater than the annual average increases in some parts of the region. Spring precipitation is expected to decline across most of the region (Figure. 15.4), but future changes in the summer rainy season remain uncertain.

Water Resources

Since 1999, the Southwest has experienced the most severe drought in over a century, which has been exacerbated by recent temperature increases. Studies cited by Karl et al. (2009) point to an increasing probability of future drought for the region. Warm, dry conditions have reduced spring snowpack levels and flows of major rivers like the Colorado. Droughts are features of the region's natural climate variability, but human-induced climate change may increase the incidence and severity of prolonged drought and amplify impacts to water resources. Climate impacts may also be intensified by the region's rapid population growth and increased demand for water, which has already lowered water tables in some areas due to ground water pumping. Current climate trends in addition to population growth suggest that water supplies will likely be substantially diminished in the future. Water shortages will necessitate trade-offs among competing uses—for example, agriculture, hydroelectricity, ecosystems, and urban areas.



Despite a greater likelihood of drier overall conditions in the Southwest, precipitation patterns are expected to fluctuate between extremely dry and extremely wet winters. If there is rainfall, it is more likely to occur in heavy downpours and may trigger rain-on-snow events (i.e., rapid snowmelt associated with heavy rainfall). The projected future increase in the amount of precipitation falling as rain rather than snow in lower mountain elevations also contributes to the likelihood of flooding.

Forestry and Ecosystems

In recent years, rising temperatures and related reductions in spring snowpack and soil moisture have led to record wildfires (Karl et al., 2009). Overall total area burned by wildfire is projected to increase, although the likelihood of impacts at any given location will depend on local conditions. Some forest types, such as piñon pine-juniper woodlands in the Four Corners region of the Southwest, have experienced substantial die-off due to the severity of current drought conditions and are at greater risk of wildfire. Grasslands are also projected to expand in some areas of the Southwest as a result of increasing temperatures and shifting precipitation patterns, which will likely increase fire risk.

Climate-sensitive ecosystems such as high-elevation alpine forests and tundra are expected to decline under future temperature and precipitation changes. In California, studies project that high-elevation forests will be reduced by 60 to 90% by the end of the century under higher emissions scenarios. Climate change is also expected to threaten the future viability of globally significant biodiversity “hotspots” of

the Southwest such as the Madrean pine-oak woodlands, which presently exist only in isolated mountaintop patches in southern Arizona, New Mexico, and West Texas. This unique ecosystem contains numerous endemic plant and animal species as well as the greatest diversity of pine species in the world.

In response to projected changes in temperature, precipitation, and drought patterns in the Southwest, some native species are expected to experience substantial range reductions and competition from non-native and invasive species. Studies cited in Karl et al. (2009) project that two-thirds of the more than 5,500 native plant species in California will decline up to 80% by the end of the century under higher emissions scenarios. The Sonoran Desert is already being invaded by red brome and buffle grasses native to Africa and may be threatened with future loss of its iconic species, the saguaro cactus. Some species may be able to shift their ranges northward and upward in elevation to cooler climates but will be challenged by the mountainous topography and human-caused fragmentation of the landscape.

Regional Infrastructure, Economy, and Health

Increased risk of wildfire and flooding expected under future climate change threatens infrastructure and the region's rapidly expanding cities. In addition, projected temperature increases in a region that already experiences very high summer temperatures and poor air quality will significantly stress human health, electricity, and water supply. This will be particularly evident in major cities such as Phoenix, Albuquerque, and Las Vegas, and many California cities with substantial urban heat island effects. More intense, longer-lasting heat wave events are projected to occur over this century, which may increase risks of electricity brownouts and blackouts as demands for air conditioning increase. Hydroelectric systems will also be affected by changes in the timing and amount of river flows, particularly in areas with limited storage capacity.

Much of the region's agriculture may be negatively impacted by future warming, particularly specialty crops in California such as apricots, almonds, artichokes, figs, kiwis, olives, and walnuts. These crops require a minimum number of hours at a certain winter temperature threshold to become dormant and set fruit for the following year. Tourism and outdoor recreation, also important to the region's economy, will be affected by increasing temperatures and changing precipitation patterns. The winter recreation and associated businesses such as downhill and cross-country skiing, snowshoeing, and snowmobiling will likely be affected by a decline in snowpack. Under a high emissions scenario 40% to almost 90% decreases in end-of-season snowpack have been projected in counties with major ski resorts from New Mexico to California. The recreational experience of hikers, bikers, birders, boaters, and others may be affected by reductions in river flow and lake/reservoir levels and changes to the region's iconic ecosystems and landscapes.

15(f) Northwest

Studies cited by Karl et al. (2009) indicate that average annual temperature in the Northwest rose about 1.5°F (0.83°C) over the past century, with some areas experiencing increases up to 4°F (2°C). By the end of the century, regional temperature is projected to increase another 3°F to 10°F (2 to 5.6°C) under lower and higher emissions scenarios, respectively. Precipitation is expected to increase in the winter and decrease in the summer, though these projections are less certain than those for temperature.

Water and Coastal Resources

The majority of the Northwest is highly dependent on water stored in spring snowpack to maintain streamflow throughout the summer (measured as April 1 snow water equivalent). April 1 snowpack has already declined substantially throughout the region and is projected to decline up to 40% in the Cascades by the 2040s. Warming temperatures will cause more precipitation to fall as rain rather than snow and contribute to earlier snowmelt and major changes in the timing of runoff. Over the past 50 years, the peak spring runoff has occurred up to 25 to 30 days earlier and this trend is projected to continue, with runoff shifting 20 to 40 days earlier within this century. Streamflow is projected to increase in winter and early spring but decrease in late spring, summer, and fall. Given these changes, some sensitive watersheds may experience both increased flood risk in winter and increased drought risk in summer.

Sea level rise will likely contribute to increased coastal erosion and loss of beaches in the Northwest. Some climate models have projected changes in atmospheric pressure patterns that suggest a more southwesterly direction of future winter winds. This change, combined with higher sea levels, would accelerate coastal erosion all along the Pacific Coast. Risk of landslides on coastal bluffs may increase due to the projected heavier winter rainfall that saturates soils and causes them to become unstable.

Forestry and Ecosystems

In recent decades, the risk of forest fires has risen as the region has experienced higher summer temperatures, earlier spring snowmelt, and increased summer moisture deficits; this trend is expected to continue under future climate change. In the short term, the growth of high elevation forests on the west side of the Cascade Mountains is expected to increase; however, projected soil moisture deficits will likely decrease tree growth and limit forest productivity over the long term, with low elevation forests experiencing these changes first. The extent and species composition of Northwest forests are also expected to change in response to climate change. The frequency and intensity of mountain pine beetle and other insect attacks is likely to rise, which may further increase fire risk as the number of standing dead trees increases. Local populations of plants and animals may become extirpated if species are unable or if environmental changes outpace their ability to shift their ranges to more favorable habitat. For example, already threatened or endangered species like wild Pacific salmon will be further impacted by earlier peak streamflows, lower summer streamflows, warmer water temperatures, and changes in the ocean environment. Studies cited by Karl et al. (2009) indicate that about one-third of the current habitat for the Northwest's salmon and other cold-water fish will no longer be suitable for them by the end of this century when temperature surpasses key thresholds.

Regional Infrastructure and Economy

The Northwest's network of dams and reservoirs are operated for a complex set of competing uses—including flood protection, hydropower, municipal and industrial uses, agricultural irrigation, navigation, and ecosystem protection—and is not designed to accommodate projected precipitation and streamflow changes. For example, reservoirs might have to release (rather than store) large amounts of runoff during the winter and early spring to fulfill flood protection objectives, leaving the region without a reliable water supply for hydroelectric power production in summer and early fall when temperatures reach their peak and electricity demand for air conditioning and refrigeration is greatest. Conflicts and the need for trade-offs between all of these water uses are expected to increase.

Much of the region's agriculture, especially production of tree fruit such as apples, is likely to be negatively impacted by future warming and precipitation changes. Impacts may include a decline water supply for irrigation, an increase in insect pests and disease, and increased competition from weeds. The

projected decline in forest productivity and limited tree growth may affect the Northwest's timber industry.

15(g) Alaska

Over the past 50 years, Alaska's annual average temperature has increased by 3.4°F (1.9°C) and winters have warmed by 6.3°F (3.5°C), which is more than twice the rate of the rest of the United States. These observed changes are consistent with climate model projections of temperature increases in Alaska of 4 to 7°F (2 to 4°C) by mid-century. Climate models also project precipitation increases; however, higher air temperatures coupled with increased evaporation are expected to result in reduced soil moisture and drier overall conditions.

Forestry and Ecosystems

Alaska's higher average annual temperatures are already contributing to earlier spring snowmelt, reduced sea ice, widespread glacier retreat, and permafrost thawing. Across southern Alaska, increased rates of evaporation and permafrost thawing have reduced areas covered by surface waters, particularly closed-basin lakes (i.e., lakes without stream inputs and outputs). Drought stress has substantially reduced the rate of growth in white spruce forests in interior Alaska, and continued warming could lead to widespread tree mortality. Alaska's tree line is shifting northward into tundra, impacting wildlife such as migratory birds and caribou that depend on open tundra habitat.

Warmer, drier conditions have also led to an increased incidence of forest insect pest outbreaks and wildfire. The largest outbreak of spruce beetles in the world occurred in south-central Alaska during the 1990s, worsened by a multi-year drought that left trees too stressed to withstand the infestation. Outbreaks of spruce budworm are also expected to increase as summers become warmer and drier; prior to 1990, interior Alaskan winters were too severe for this species to reproduce. Pest infestations can create large, dense areas of dead trees, which are highly flammable and increase the likelihood of wildfire. The area burned by wildfire in Alaska and northwest Canada tripled between the 1960s and the 1990s. Under future climate conditions, the average area burned per year in Alaska is projected to double by mid-century. By the end of this century, area burned by fire could triple or quadruple under moderate or higher GHG emissions scenarios.

Regional Infrastructure and Economy

Throughout Alaska, warming air temperatures have increased permafrost temperatures to the point of thawing, putting roads, runways, water and sewer systems, and other infrastructure at risk from land subsidence. Forest ecosystems are also threatened as thawing permafrost undermines tree root systems. Agriculture may benefit from longer summers and growing seasons associated with warming temperatures. However, crop production may also be negatively affected due to an increased likelihood of summer drought and decreased soil moisture.

Over this century, increased sea surface temperatures and reduced sea ice cover are likely to lead to northward shifts in the Pacific storm track, an increased frequency and/or intensity of storms, and increased impacts on Alaska's coasts. High-wind events have already become more frequent along the western and northern coasts and the rate of erosion along Alaska's northeastern coastline has doubled over the past 50 years. Coastal areas are increasingly vulnerable to wind and wave damage due to the loss of their protective sea ice buffer, increasing storm activity, and thawing coastal permafrost. These impacts are especially significant given that Alaska has more coastline than all other U.S. states combined.

Potential benefits of reduced sea ice include increased economic opportunities such as shipping and resource extraction. Potential negative effects include increased coastal erosion and flooding associated with coastal storms. Rising air and water temperatures and reduced sea ice will also affect the timing and location of plankton blooms, which may displace marine species dependent on plankton such as pollock and other commercial fish stocks, seabirds, seals, and walrus. Species ranges are shifting northward in search of colder waters and food sources; one study found that between 1982 and 2006, the center of the range for the examined species moved 19 miles (31 km) north. The commercial fishing industry may be affected by rising costs as the most productive commercial fisheries move further away from existing fishing ports and processing infrastructure, requiring either relocation or increased transportation time and fuel expense.

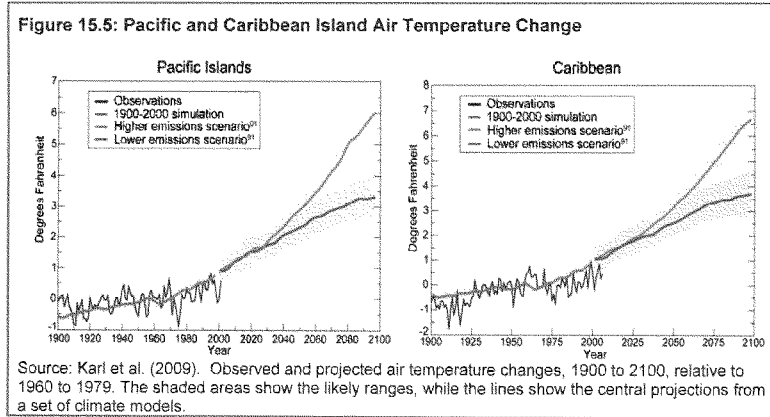
Native Alaskans

Climate change threatens the livelihoods and communities of the indigenous peoples of Alaska, whose cultural identities often depend on traditional ways of collecting and sharing food. Reduced sea ice is already affecting the availability and accessibility of seal, walrus, and fish populations that are traditional food sources for Native Alaskans. Caribou, another traditional food source, are likely to be affected by future warming since their migration patterns depend on being able to cross frozen rivers and wetlands. In addition, over 100 Native Alaskan villages on the coast and in low-lying areas along rivers are at risk of increased flooding and erosion due to warming.

15(h) Islands

Impacts from a changing climate pose challenges to the U.S.-affiliated islands of the Caribbean and Pacific. In the Caribbean, this includes Puerto Rico and the U.S. Virgin Islands. In the Pacific, this includes the Hawaiian Islands, American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau. According to studies cited by Karl et al. (2009), the Caribbean and Pacific islands have experienced rising air temperatures over the last century, with even larger increases (up to 6 or 7°F [3 or 4°C]) under higher emissions scenarios) projected for the future (Figure 15.5). Ocean surface temperatures in both the Pacific and Caribbean are also expected to increase. Average annual precipitation is projected to decrease in the Caribbean, while the Pacific Islands are expected to experience an increased frequency of heavy downpours and increased rainfall in summer rather than the normal winter rainy season (although projections are less certain).

Small islands are considered among the most vulnerable to climate change; however, the degree to which climate change will affect each island depends upon a variety of factors, including the island's geology, area, height above sea level, extent of reef formation, and the size of its freshwater aquifer. Although the exact nature and magnitude of climate change impacts will be unique for each island, the following discussion highlights general types of impacts the U.S.-affiliated islands are expected to experience under a changing climate.



Water Resources

The majority of islands in the Pacific and the Caribbean have limited sources of the freshwater needed to support unique ecosystems, public health, agriculture, and tourism. These limited water resources are already strained in some areas by a rapidly rising population. Because rainfall and tropical storms serve to replenish ground water supplies, the significant decreases in precipitation projected for the Caribbean and changes in tropical storm patterns will likely reduce the availability of freshwater. In the Pacific Islands, potential positive impacts of projected increases in rainfall during the summer months include an increased seasonal water supply. Potential negative impacts include increased flooding, which would increase the risk of water contamination from agricultural or sewage pollution. Sea level rise and increased frequency of flooding from higher storm tides may also increase risk of contamination of the freshwater supply by saltwater.

Island Coastal and Marine Ecosystems

Sea level rise will likely contribute to increased erosion and permanent loss of shorelines and coastal land, particularly in low-lying island areas. "Extreme" sea level days (with a daily average of more than 6 inches (15 cm) above the long-term average) and their associated impacts may also result from a combination of gradual sea level rise, seasonal heating, and high tides. Flooding is expected to become more frequent due to higher storm tides. Certain plant and animal species, many of which are endemic to specific islands and exist nowhere else in the world, may experience habitat loss as a result of these impacts, potentially threatening the survival of many already vulnerable species. Sea level rise, increasing storm damage, warmer water temperatures, and ocean acidification due to a rising carbon dioxide concentration will likely contribute to a decline in important island ecosystems such as mangroves and coral reefs. Even small increases in water temperature can cause coral bleaching, which damages and kills corals. If carbon dioxide concentrations continue to rise at their current rate, the Florida Keys, Puerto Rico, Hawaii, and the Pacific Islands are projected to lose their coral reef ecosystems as a result of these stresses.

Island Infrastructure and Economy

Hurricanes, typhoons, and other storm events, with their intense precipitation and storm surge, already cause major impacts to Pacific and Caribbean island communities each year. As the climate continues to warm, peak wind intensities and precipitation from future tropical cyclones are likely to increase. This in addition to sea level rise is expected to cause higher storm surge levels and flooding that could potentially impact critical infrastructure such as communications, port facilities and harbors, roads, airports, and bridges. Many islands already have weak water distribution systems and old infrastructure, which would be severely strained by extreme events. Long-term infrastructure damage would affect communities' ability to recover between events and increase costs associated with disaster risk management, health care, education, management of freshwater resources, and food production.

The tourism and fisheries industries, critical to most island economies, would be impacted by climate changes affecting freshwater supplies, infrastructure, and coastal and marine ecosystems, particularly coral reefs. In the Caribbean, coral reefs provide between \$3.1 billion and \$4.6 billion of annual net benefits from fisheries, tourism, and shoreline protection services. The loss of income from degraded reefs is conservatively estimated at several hundred million dollars annually by 2015.

Part V

**Observed and Projected Human Health and Welfare Effects From
Climate Change in Other World Regions**

Section 16

Impacts in Other World Regions

The primary focus of this document is on the observed and potential future impacts associated with elevated GHG concentrations and associated climate change within the United States. However, EPA has considered the global nature of climate change in at least two ways for purposes of this document.

First, GHGs, once emitted, remain in the atmosphere for decades to centuries, and thus become, for all practical purposes, uniformly mixed in the atmosphere, meaning that U.S. emissions have climatic effects not only in the United States but in all parts of the world. Likewise, GHG emissions from other countries can influence the climate of the United States, and therefore affect human health, society, and the natural environment within the United States. All observed and potential future climate change impacts within the United States reviewed in this document consider climate change driven by *global* anthropogenic GHG emissions.

Second, despite widely discussed metrics such as global average temperature, climate change will manifest itself very differently in different parts of the world, where regional changes in temperatures and precipitation patterns, for example, can deviate significantly from changes in the global average. This regional variation in climate change, coupled with the fact that countries are in very different positions with respect to their vulnerability and adaptive capacity, means that the impacts of climate change will be experienced very differently in different parts of the world. In general, the relatively poor nations may experience the most severe impacts, due to their heavier reliance on climate-sensitive sectors such as agriculture and tourism, and due to their lack of resources for increasing resilience and adaptive capacity to climate change (see Parry et al., 2007). In addition to the fact that U.S. GHG emissions contribute to these impacts (see Section 2 for a comparison of U.S. total and transportation emissions to other countries' emissions), climate change impacts in certain regions of the world will have political, social, economic, and environmental ramifications for the United States. Climate change has the potential to alter trade relationships and may exacerbate problems that raise humanitarian and national security issues for the United States (Karl et al., 2009).

16(a) National Security Concerns

A number of analyses and publications inside and outside the government have focused on the potential U.S. national security implications of climate change.⁸⁵ For the most part, this body of work has been developed by organizations such as the Center for Naval Analyses (CNA) Corporation and National Intelligence Council rather than teams of scientists. These organizations have leveraged their national security expertise to synthesize the potential security implications of various climate impacts. The recent USGCRP scientific assessment (Karl et al., 2009) has also recognized this issue, stating:

In an increasingly interdependent world, U.S. vulnerability to climate change is linked to the fates of other nations. For examples, conflicts or mass migrations of people resulting from food scarcity and other resource limits, health impacts, or environmental stresses in other parts of the world could threaten U.S. national security ... Meeting the challenge of improving conditions for the world's poor has economic implications for the United States, as does intervention and resolution of intra- and intergroup conflicts. Where climate change exacerbates such challenges,

⁸⁵ As the discussion on the national security risks of climate change is limited in the assessment literature, this section relies upon the following sources: U.S. government-published or -funded analyses — including the 2009 assessment report *Global Climate Change Impacts in the United States* — and a report by the Center for Naval Analyses (CNA) Corporation. These sources typically rely on the assessment literature for their underlying science.

for example by limiting access to scarce resources or increasing incidence of damaging weather events, consequences are likely for the U.S. economy and security.”

A public report prepared for the Department of Defense (Schwartz and Randall, 2003) examined what the effects on U.S. national security might be from an abrupt climate change scenario.⁸⁶ Based on their interviews with leading climate scientists and their independent research, the authors conclude that the resultant climatic conditions could lead to resource constraints and potentially destabilize the global geopolitical environment, with resultant national security concerns for the United States.

ACIA (2004) raised security issues, stating that as Arctic sea ice declines, historically closed sea passages will open, thus raising questions regarding sovereignty over shipping routes and ocean resources. In IPCC (Anisimov, 2007), a study shows projections suggesting that by 2050, the Northern Sea Route will have 125 days per year with less than 75% sea ice cover, which represents favorable conditions for navigation by ice-strengthened cargo ships. This may have implications for trade and tourism as well.

CNA Corporation, a nonprofit national security analysis institution, issued a report entitled *National Security and the Threat of Climate Change* (2007), in which a dozen retired generals and admirals prepared an assessment of the threats of climate change to national security, based on briefings from the U.S. intelligence community, climate scientists, and business and state leaders. Among their conclusions was that climate change acts as a “threat multiplier” for instability in some of the most volatile regions of the world. “Projected climate change will seriously exacerbate already marginal living standards in many Asian, African, and Middle Eastern nations, causing widespread political instability and the likelihood of failed states,” said the authors. Regarding the potential impact of climate change on military systems, infrastructure and operations, the report stated that climate change will stress the U.S. military by affecting weapons systems and platforms, bases, and military operations. A U.S. Navy (2001) study was cited which states that an ice-free Arctic will require an increased scope for naval operations. Given these concerns, one of the recommendations of the CNA (2007) report was for the Department of Defense to conduct an assessment of the impact on U.S. military installations worldwide of rising sea levels, extreme weather events, and other possible climate change impacts over the next 30 to 40 years.

The U.S. Congress has recognized there are potential national security concerns due to climate change and requested that the defense and intelligence communities examine these linkages. H.R. 4986, passed in January 2008, requires the Department of Defense to consider the effect of climate change on its facilities, capabilities, and missions. Specific directives in the bill include that future national security strategies and national defense strategies must include guidance for military planners to assess the risks of projected climate change on current and future armed forces missions, as well as update defense plans based on these assessments (H.R. 4986, 2008).

In June 2008 testimony before the House, Dr. Thomas Fingar, Deputy Director of National Intelligence for Analysis, laid out a national intelligence statement on the U.S. national security implications from climate change projected out to 2030. Using a broad definition for national security,⁸⁷ the assessment found that:

⁸⁶ The abrupt climate change used for the study was the unlikely, but plausible, collapse of the thermohaline circulation in the Atlantic, modeled after an event that occurred 8,200 years ago.

⁸⁷ This definition of national security considered if the effects would directly impact the U.S. homeland, a U.S. economic partner, or a U.S. ally. Additionally, the potential for humanitarian disaster was focused on as well as if an effect would result in degrading or enhancing an element of national power. For more information, see Fingar, 2008.

“[G]lobal climate change will have wide-ranging implications for U.S. national security interests over the next 20 years...We judge that the most significant impact for the United States will be indirect and result from climate-driven effects on many other countries and their potential to seriously affect U.S. national security interests. We assess that climate change alone is unlikely to trigger state failure in any state out to 2030, but the impacts will worsen existing problems—such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions. Climate change could threaten domestic stability in some states, potentially contributing to intra- or, less likely, interstate conflict, particularly over access to increasingly scarce water resources.” (Fingar, 2008)

Building on that work, the National Intelligence Council in November 2008, in its publication *Global Trends 2025: A Transformed World*, discussed climate change impacts prominently. The report posed a scenario named “October Surprise,” which discussed the economic and sociopolitical ramifications of an extreme flooding event linked to global climate change in New York City in 2020 (NIC, 2008).

16(b) Overview of International Impacts

The IPCC Working Group II volume of the *Fourth Assessment Report* reviews the potential impacts in different regions of the world. The IPCC (Parry et al., 2007) identifies as the most vulnerable regions:

- The Arctic, because of high rates of projected warming on natural systems.
- Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change.
- Small islands, due to high exposure of population and infrastructure to risk of sea level rise and increased storm surge.
- Asian mega deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge and river flooding.

Table 16.1 summarizes the vulnerabilities and projected impacts for different regions of the world, as identified by the IPCC (2007b); the paragraphs that follow provide some additional detail for key sectoral impacts that have received attention by the research community.

On a global basis, according to IPCC, “projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity,” through several factors including “the increased frequency of cardio-respiratory diseases due to higher concentrations of ground level ozone related to climate change (IPCC, 2007b).” More specifically, “cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts.”

Mosquito-borne diseases which are sensitive to climate change, such as dengue and malaria are of great importance globally. Studies cited in Confalonieri et al. (2007) have reported associations between spatial, temporal, or spatiotemporal patterns of dengue and climate, although these are not entirely consistent. Similarly, the spatial distribution, intensity of transmission, and seasonality of malaria is observed to be influenced by climate in sub-Saharan Africa (Confalonieri et al., 2007). In other world regions (e.g., South America, continental regions of the Russian Federation), there is no clear evidence that malaria has been affected by climate change (Confalonieri et al., 2007). Changes in reporting, surveillance, disease control measures, population, land use, and other factors must to be taken into account when attempting to attribute changes in human diseases to climate change (Confalonieri et al., 2007).

Food production is expected to be much more vulnerable to climate change in poorer regions of the world compared to food production in the United States and other high, northern latitude regions. The IPCC (2007b) stated with medium confidence⁸⁸ that, at lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (~2 to 3.5°F [1 to 2°C]), which would increase risk of hunger. Furthermore, increases in the frequency of droughts and floods are projected to affect local production negatively, especially in subsistence sectors at low latitudes. Drought conditions, flooding, and pest outbreaks are some of the current stressors to food security that may be influenced by future climate change. Sub-Saharan Africa is currently highly vulnerable to food insecurity (Easterling et al., 2007). A study cited by Easterling et al. (2007) projected increases in carbon storage on croplands globally under climate change up to 2100 but found that ozone damage to crops could significantly offset these gains.

Regarding global forest production, the IPCC (Easterling et al., 2007) concluded that forestry production is estimated to change modestly with climate change in the short- and medium-term (medium confidence). The projected change in global forest products output ranges from a modest increase to a slight decrease, with significant variations regionally. There is projected to be a production shift from low latitude regions in the short-term, to high latitude regions in the long-term. Projected changes in the frequency and severity of extreme climate events have significant consequences for forestry production in addition to impacts of projected mean climate (high confidence) (Easterling et al., 2007). Climate variability and change also modify the risks of fires, and pest and pathogen outbreaks, with negative consequences for forestry (high confidence) (Easterling et al., 2007).

The IPCC made the following conclusions when considering how climate change may affect water resources across all world regions:

- The impacts of climate change on freshwater systems and their management are mainly due to the observed and projected increases in temperature, sea level, and precipitation variability (very high confidence) (Kundzewicz et al., 2007).
- All regions show an overall net negative impact of climate change on water resources and freshwater ecosystems (high confidence). Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources (very high confidence). The beneficial impacts of increased annual runoff in other areas will be tempered by negative effects due to increased precipitation variability and seasonal runoff shifts on water supply, water quality, and flood risk (high confidence) (Kundzewicz et al., 2007).
- Climate change affects the function and operation of existing water infrastructure as well as water management practices. Adverse effects of climate change on freshwater systems aggravate the impacts of other stresses, such as population growth, changing economic activity, land-use change, and urbanization. Globally, water demand will grow in the coming decades, primarily due to population growth and increased affluence; regionally, large changes in irrigation water demand as a result of climate changes are likely. Current water management practices are very likely to be inadequate to reduce negative impacts of climate change on water supply reliability, flood risk, health, energy, and aquatic ecosystems (very high confidence) (Kundzewicz et al., 2007).

⁸⁸ According to IPCC terminology, “medium confidence” conveys a 5 out of 10 chance of being correct. See Box 1.2 for a full description of IPCC’s uncertainty terms.

- In polar regions, components of the terrestrial cryosphere and hydrology are increasingly being affected by climate change. Changes to cryospheric processes⁸⁹ are also modifying seasonal runoff (very high confidence) (Anisimov et al., 2007).

The IPCC (Nicholls et al., 2007) identified that coasts are experiencing the adverse consequences of hazards related to climate and sea level (very high confidence). They are highly vulnerable to extreme events, such as storms which impose substantial costs on coastal societies. Through the 20th century, global rise of sea level contributed to increased coastal inundation, erosion, and ecosystem losses but with considerable local and regional variation due to other factors (Nicholls et al., 2007). Many large cities are located in areas that are vulnerable to sea level rise and flooding. In most of these cities, the poor often live in areas that are susceptible to extreme events and face constraints on their ability to adapt (Karl et al., 2009).

The IPCC (Fischlin et al., 2007) recently made the following conclusions when considering how climate change may affect ecosystems across all world regions:

- During the course of this century, the resilience of many ecosystems is likely to be exceeded by an unprecedented combination of changes in climate and in other global change drivers (especially land use, pollution, and overexploitation), if GHG emissions and other changes continue at or above current rates (high confidence). The elevated CO₂ levels and associated climatic changes will alter ecosystem structure, reduce biodiversity, perturb functioning of most ecosystems, and compromise the services they currently provide (high confidence). Present and future land-use change and associated landscape fragmentation are very likely to impede species' migrations and geographic range shifts in response to changes in climate (very high confidence).
- Ecosystems and species are very likely to show a wide range of vulnerabilities to climate change, depending on the extent to which climate change alters conditions that could cross critical, ecosystem-specific thresholds (very high confidence). The most vulnerable ecosystems include coral reefs, the sea ice biome and other high latitude ecosystems (e.g., boreal forests), mountain ecosystems, and Mediterranean-climate ecosystems⁹⁰ (high confidence). Least vulnerable ecosystems include savannas and species-poor deserts, but this assessment is especially subject to uncertainty relating to the CO₂ fertilization effect and disturbance regimes such as fire (low confidence).

While there is currently a lack of information about how potential impacts due to climate change may influence trade and migration patterns, there is considerable evidence that they will be affected. The USGCRP (Karl et al., 2009) concluded that the number of people wanting to immigrate to the United States will increase as conditions worsen elsewhere, and that climate change has the potential to alter trade relationships by changing the comparative trade advantages of regions or nations. Shifts in both trade and migration can have multiple causes and the direct cause of potential increased migration, such as extreme climatic events, will be difficult to separate from other forces that drive people to migrate (Karl et al., 2009).

⁸⁹ Cryospheric processes are defined to include the annual freezing and melting of snow cover, ice sheets, lake and river ice, permafrost, and sea ice.

⁹⁰ Mediterranean climate ecosystems feature subtropical climate with dry summers. Despite the name, these ecosystems exist in the United States along the coasts of central and southern California.

Table 16.1: Examples of Key Regional Impacts as Identified by IPCC (2007b)	
Africa	<ul style="list-style-type: none"> • New studies confirm that Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. Some adaptation to current climate variability is taking place; however, this may be insufficient for future changes in climate. • By 2020, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems. • Agricultural production, including access to food, in many countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons, and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.
Asia	<ul style="list-style-type: none"> • Glacier melt in the Himalayas is projected to increase flooding and rock avalanches from destabilized slopes and to affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. • Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease due to climate change, which, along with population growth and increasing demand arising from higher standards of living, could adversely affect more than a billion people by the 2050s. • Coastal areas, especially heavily populated mega delta regions in South, East, and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some mega deltas, flooding from the rivers. • It is projected that crop yields could increase up to 20% in East and South-East Asia, while they could decrease up to 30% in Central and South Asia by the mid-21st century. The risk of hunger is projected to remain very high in several developing countries. • Endemic morbidity and mortality due to diarrhea disease primarily associated with floods and droughts is expected to rise in East, South, and South-East Asia due to projected changes in the hydrological cycle associated with global warming. Increases in coastal water temperature would exacerbate the abundance and/or toxicity of cholera in South Asia.
Latin America	<ul style="list-style-type: none"> • By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation. There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America. • In drier areas, climate change is expected to lead to salinization and desertification of agricultural land. Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. • Sea level rise is projected to cause increased risk of flooding in low-lying areas. Increases in sea surface temperature due to climate change are projected to have adverse effects on Mesoamerican coral reefs and cause shifts in the location of Southeast Pacific fish stocks. • Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture, and energy generation.

Polar Regions	<ul style="list-style-type: none"> • For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions, are projected to be mixed. Detrimental impacts would include those on infrastructure and traditional indigenous ways of life. • Beneficial impacts would include reduced heating costs and more navigable northern sea routes.
Small Islands	<ul style="list-style-type: none"> • Small islands, whether located in the tropics or at higher latitudes, have characteristics that make them especially vulnerable to the effects of climate change, sea level rise, and extreme events. • Deterioration in coastal conditions (e.g., through erosion of beaches and coral bleaching) is expected to affect local resources (e.g., fisheries) and reduce the value of these destinations for tourism. • Sea level rise is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards, thus threatening vital infrastructure, settlements, and facilities that support the livelihood of island communities. • By mid-century climate change is projected to reduce water resources in many small islands, (e.g., in the Caribbean and Pacific), to the point where they become insufficient to meet demand during low-rainfall periods.
<p>* With the exception of some very high-confidence statements for small islands, all other IPCC conclusions within this box are of either high or medium confidence.</p>	

References

- ACIA (2004) *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*. Cambridge University Press.
- Alley, R.B., J. Brigham-Grette, G.H. Miller, L. Polyak, and J.W.C. White (2009) Key Findings and Recommendations. In: *Past Climate Variability and Change in the Arctic and at High Latitudes*. A report by the U.S. Climate Change Program and Subcommittee on Global Change Research. U.S. Geological Survey, Reston, VA, pp. 421–430.
- Anisimov, O.A. et al. (2007) Polar Regions. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Backlund, P., A. Janetos, D.S. Schimel, J. Hatfield, M.G. Ryan, S.R. Archer, and D. Lettenmaier (2008a) Executive Summary. In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.
- Backlund, P., D. Schimel, A. Janetos, J. Hatfield, M.G. Ryan, S.R. Archer, and D. Lettenmaier (2008b) Introduction. In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.
- Baldwin, M. et al. (2007) Climate-Ozone connections, Chapter 5. In *Scientific Assessment of Ozone Depletion: 2006*. Global Ozone Research and Monitoring Project—Report No. 50, Geneva, Switzerland, 572 pp.
- Bates, B.C., Z.W. Kundzewicz, S. Wu, and J.P. Palutikof, (Eds.), (2008): *Climate Change and Water*. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.
- Bell, M.L., Goldberg, C. Hogrefe, P.L. Kinney, K. Knowlton, B. Lynn, J. Rosenthal, C. Rosenweig, and J. Patz (2007) Climate Change, ambient ozone, and health in 50 U.S. cities. *Climate Change*, DOI 10.1007/s10584-006-9166-7.
- Bindoff, N.L. et al. (2007) Observations: Oceanic Climate Change and Sea Level. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Bodeker et al. (2007) The ozone layer in the 21st century, Chapter 6. In *Scientific Assessment of Ozone Depletion: 2006*. Global Ozone Research and Monitoring Project—Report No. 50, Geneva, Switzerland, 572 pp.
- Brasseur, G.P., et al. (2006) Impact of Climate Change on the Future Chemical Composition of the Global Troposphere, *Journal of Climate*, 19, 3932-3951.
- Brennan, W. (2007). Clarification of review and clearance process for CCSP Synthesis and Assessment Products: Memorandum, dated 3 August 2007 to CENR and CCSP principals from William Brennan, Acting Director, U.S. Climate Change Science Program. <http://www.climate-science.gov/Library/sap/sap-guidelines-clarification-aug2007.htm>. Accessed December 6, 2009.
- Cahoon, D.R., D.J. Reed, A.S. Kolker, M.M. Brinson, J.C. Stevenson, S. Riggs, R. Christian, E. Reyes, C. Voss, and D. Kunz (2009) Coastal Wetland Sustainability. In: *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-*

- Atlantic Region*. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington DC, USA, 320 pp.
- California Climate Change Center (2006) *Scenarios of Climate Change in California: An Overview*. CEC-500-2005-186-SF.
- California Energy Commission (2006) *Our Changing Climate: Assessing the Risks to California*. [Accessed 08.08.07: <http://www.energy.ca.gov/2006publications/CEC-500-2006-077/CEC-500-2006-077.PDF>]
- Canadian Centre for Occupational Health and Safety (CCOHS) 1990. CHEMINFO database search.
- CCSP (2009a) *Atmospheric Aerosol Properties and Impacts on Climate*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Mian Chin, Ralph A. Kahn, and Stephen E. Schwartz (eds.)]. National Aeronautics and Space Administration, Washington, D.C., USA, 139 pp.
- CCSP (2009b) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams (Lead Authors)], U.S. Environmental Protection Agency, Washington DC, USA, 320 pp.
- CCSP (2009c) *Past Climate Variability and Change in the Arctic and at High Latitude*. A Report by the U.S. Climate Change Program and Subcommittee on Global Change Research [Alley, R.B., Brigham-Grette, J., Miller, G.H., Polyak, L., and White, J.W.C. (coordinating lead authors)]. U.S. Geological Survey, Reston, VA, 461 pp.
- CCSP (2009d) *Thresholds of Climate Change in Ecosystems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Fagre, D.B., C.W. Charles, C.D. Allen, C. Birkeland, F.S. Chapin III, P.M. Groffman, G.R. Guntenspergen, A.K. Knapp, A.D. McGuire, P.J. Mulholland, D.P.C. Peters, D.D. Roby, and George Sugihara]. U.S. Geological Survey, Reston, VA, 156 pp.
- CCSP (2008a) *Abrupt Climate Change*. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Clark, P.U., A.J. Weaver (coordinating lead authors), E. Brook, E.R. Cook, T.L. Delworth, and K. Steffen (chapter lead authors)]. U.S. Geological Survey, Reston, VA, 459 pp.
- CCSP (2008b) *Analyses of the effects of global change on human health and welfare and human systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA.
- CCSP (2008c) *Climate Models: An Assessment of Strengths and Limitations*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Bader D.C., C. Covey, W.J. Gutowski Jr., I.M. Held, K.E. Kunkel, R.L. Miller, R.T. Tokmakian and M.H. Zhang (Authors)]. Department of Energy, Office of Biological and Environmental Research, Washington, DC, USA, 124 pp.
- CCSP (2008d) *Climate Projections Based on Emissions Scenarios for Long-Lived and Short-Lived Radiatively Active Gases and Aerosols*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [H. Levy II, D.T. Shindell, A. Gilliland, M.D. Schwarzkopf, L.W. Horowitz (eds.)]. Department of Commerce, Washington, DC, USA, 100 pp.
- CCSP (2008e) *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [P. Backlund, A. Janetos, D. Schimel et al.] U.S. Department of Agriculture, Washington, DC, USA, 362 pp.

- CCSP (2008f) *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Savonis, M. J., V.R. Burkett, and J.R. Potter (eds.)]. Department of Transportation, Washington, DC, USA, 445 pp.
- CCSP (2008g) *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Randall Dole, Martin Hoerling, and Siegfried Schubert (eds.)]. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, 156 pp.
- CCSP (2008h) *Trends in Emissions of Ozone-Depleting Substances, Ozone Layer Recovery, and Implications for Ultraviolet Radiation Exposure*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Ravishankara, A.R., M.J. Kurylo, and C.A. Ennis (eds.)]. Department of Commerce, NOAA's National Climatic Data Center, Asheville, NC, 240 pp.
- CCSP (2008i) *Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Thomas R. Karl, Gerald A. Meehl, Christopher D. Miller, Susan J. Hassol, Anne M. Waple, and William L. Murray (eds.)]. Department of Commerce, NOAA's National Climatic Data Center, Washington, DC, USA, 164 pp.
- CCSP (2007a) *Effects of Climate Change on Energy Production and Use in the United States*. A Report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research [Thomas J. Wilbanks, Vatsal Bhatt, Daniel E. Bilello, Stanley R. Bull, James Ekmann, William C. Horak, Y. Joe Huang, Mark D. Levine, Michael J. Sale, David K. Schmalzer, and Michael J. Scott]. Department of Energy, Office of Biological & Environmental Research, Washington, DC., USA, 160 pp.
- CCSP (2007b) *Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations (Part A) and Review of Integrated Scenario Development and Application (Part B)*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Clarke, L., J. Edmonds, J. Jacoby, H. Pitcher, J. Reilly, R. Richels, E. Parson, V. Burkett, K. Fisher-Vanden, D. Keith, L. Mearns, H. Pitcher, C. Rosenzweig, M. Webster (Authors)]. Department of Energy, Office of Biological & Environmental Research, Washington, DC, USA, 260 pp.
- CCSP (2006) *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*. A Report by the Climate Change Science Program and the Subcommittee on Global Change Research. [Thomas R. Karl, Susan J. Hassol, Christopher D. Miller, and William L. Murray (eds.)], Washington, DC.
- CDC (2005) Vibrio illnesses after Hurricane Katrina: multiple states, August–September (2005) *MMWR—Morbidity & Mortality Weekly Report*, 54, 928-931.
- CDC (2006). Heat-related deaths—United States, 1999-2003. *MMWR* 55:796-798.
- CENR (2008) Scientific Assessment of the Effects of Global Change on the United States, Committee on Environment and Natural Resources and National Science and Technology Council, U.S. Climate Change Science Program, 261 pp.
- Christensen, J.H. et al. (2007) Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Clark, P.U., A.J. Weaver, E. Brook, E.R. Cook, T.L. Delworth, and K. Steffen (2008) Executive Summary. In: *Abrupt Climate Change*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Geological Survey, Reston, VA, pp. 7–18.

- CNA Corporation (2007) *National Security and the Threat of Climate Change*, Alexandria, Virginia.
<http://securityandclimate.cna.org/>.
- Cohen, S., K. Miller et al. (2001) North America. In: *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [J.J. McCarthy et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Confalonieri, U. et al. (2007) Human Health. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Crossett, K.M., T.J. Culliton, P.C. Wiley, and T.R. Goodspeed (2004). *Population Trends Along the Coastal United States: 1980-2008*. NOAA publication, Silver Spring, MD.
- Denman, K.L., et al. (2007) Couplings Between Changes in the Climate System and Biogeochemistry. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Dole, R., M. Hoerling, and S. Schubert (2008) Executive summary. In: *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Randall Dole, Martin Hoerling, and Siegfried Schubert (eds.)]. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, pp. 1-4
- Easterling, W. et al. (2007) Food, Fibre and Forest Products. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson (2008) Effects of Global Change on Human Health. In: *Analyses of the effects of global change on human health and welfare and human systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, pp. 2-1 to 2-78.
- European Commission (2003) Ozone-climate interactions. In: Air pollution research report [Isaksen, I.S.A. (eds.)]. Report 81, EUR 20623, Luxembourg.
- Field, C.B. et al. (2007) North America. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Fingar, T. (2008) National Intelligence Assessment on the National Security Implications of Global Climate Change to 2030. Testimony before the House Permanent Select Committee on Intelligence and House Select Committee on Energy Independence and Global Warming, June 25, 2008.
- Fish and Wildlife Service (FWS) (2008) *Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Polar Bear (Ursus maritimus) Throughout Its Range*. 50 CFR Part 17, RIN 1018-AV19, FWS-R7-ES-2008-0038.

- Fish and Wildlife Service (FWS) (2007) *12-Month Petition Finding and Proposed Rule to List the Polar Bear (Ursus maritimus) as Threatened Through Its Range*. 50 CFR Part 17, RIN 1018-AV19.
- Fisher, B. et al. (2007) Issues related to mitigation in the long term context. In: *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Fischlin, A. et al. (2007) Ecosystems, their Properties, Goods, and Services. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Forster, P. et al. (2007) Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007. The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Gamble, J.L., K.L. Ebi, F.G. Sussman, T.J. Wilbanks, C. Reid, J.V. Thomas, C.P. Weaver, M. Harris, and R. Freed, (2008) Executive Summary. In: *Analyses of the effects of global change on human health and welfare and human systems: A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research*. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, pp. 1–11.
- Graumann, A., T. Houston, J. Lawrimore, D. Levinson, N. Lott, S. McCown, S. Stephens and D. Wuertz (2005) *Hurricane Katrina: A climatological perspective*. October 2005, updated August 2006. Technical Report 2005-01. 28 p. NOAA National Climate Data Center, available at: <http://www.ncdc.noaa.gov/oa/reports/tech-report-200501z.pdf>
- Gutierrez, B.T., S. J. Williams, and E. R. Thieler (2009) Ocean Coasts. In: *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington DC, USA, 320 pp.
- Gutowski, W.J., G.C. Hegerl, G.J. Holland, T.R. Knutson, L.O. Mearns, R.J. Stouffer, P.J. Webster, M.F. Wehner, F.W. Zwiers (2008). Causes of observed changes in extremes and projections of future changes in weather and climate extremes in a changing climate. In: T.R. Karl, G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray, eds. *Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands*. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research.
- Hadley Centre (2009) *HadCRUT3 dataset*, <http://hadobs.metoffice.com/hadcrut3/>. Accessed September 24, 2009.
- Hatfield, J., K. Boote, P. Fay, L. Hahn, C. Izaurralde, B.A. Kimball, T. Mader, J. Morgan, D. Ort, W. Polley, A. Thomson, and D. Wolfe (2008) Agriculture. In: *The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.
- Hauglustaine D.A., et al. (2005) Future tropospheric ozone simulated with a climate-chemistry-biosphere model. *Geophys. Res. Lett.*, 32, L24807, doi:10.1029/2005GL024031.
- Hegerl, G.C. et al. (2007) Understanding and Attributing Climate Change. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

- Hoerling, M., G. Hegerl, D. Karoly, A. Kumar, and D. Rind(2008) Attribution of the causes of climate variations and trends over North America during the modern reanalysis period. In: *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Randall Dole, Martin Hoerling, and Siegfried Schubert (eds.)]. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, pp. 47–92.
- Hogrefe C.B. et al. (2004) Simulating changes in regional air pollution over the eastern United States due to changes in global and regional climate and emissions, *J. Geophys. Res.*, 109: D22301.
- Horvitz, A ed., (2008) Global Climate, In: *State of the Climate in 2007*. [Levinson, D.H., and J.H. Lawrimore (eds.)], Bulletin of the American Meteorological Society, 89: S37-S61.
- H.R. 4986 (2008) PL 110-181, Jan. 28, 2008. Available from *Thomas* (Library of Congress) <http://thomas.loc.gov>; accessed 2/23/09.
- IPCC (2009). Procedures. http://www.ipcc.ch/organization/organization_procedures.htm. Accessed December 6, 2009.
- IPCC (2007a) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2007b) Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2007c) Summary for Policymakers. In: *Climate Change 2007: Mitigation*. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2007d) Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2005) Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties, available at: <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-uncertaintyguidancenote.pdf> (accessed on November 30th, 2009).
- IPCC (2001a) Summary for Policymakers. In *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [J.J. McCarthy et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2001b) Summary for Policymakers. In. *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [J.T. Houghton et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2001c) *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs,

- M. Noguera, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.
- IPCC (2000) *Special Report on Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change* [N. Nakicenovic et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (1996) *Climate Change 1995: The Science of Climate Change*. Intergovernmental Panel on Climate Change [J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg, and K. Maskell (eds.)]. Cambridge University Press, Cambridge, United Kingdom.
- IPCC (1990) *Scientific Assessment of Climate Change—Report of Working Group I* [Houghton, J.T., G.J. Jenkins and J.J. Ephraums]. Cambridge University Press, UK, pp 365.
- IPCC Technology and Economic Assessment Panel (2005) *IPCC/TEAP Special Report on Safe-guarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons*. Prepared by Working Group I and III of the IPCC, and the TEAP. [B. Metz, L. Kuijpers, S. Solomon, S.O. Andersen, O. Davidson, J. Pons, D. de Jager, T. Kestin, M. Manning, and L.A. Meyers (eds.)]. Cambridge University Press, Cambridge United Kingdom, and New York, NY, USA, 488 pp..
- Jacob, D.J., and D.A. Winner (2009) Effect of climate change on air quality, *Atmospheric Environment*, 43: 51S63.
- Janetos, A., L. Hansen, D. Inouye, B.P. Kelly, L. Meyerson, B. Peterson, and R. Shaw (2008) Biodiversity. In: *The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research*. Washington, DC., USA, 362 pp.
- Jansen, E., J. Overpeck, K.R. Briffa, J.C. Duplessy, F. Joos, V. Masson-Delmotte, D. Olago, B. Otto-Bliessner, W.R. Peltier, S. Rahmstorf, R. Ramesh, D. Raynaud, D. Rind, O. Solomina, R. Villalba and D. Zhang (2007) Palaeoclimate. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Karl, T., J. Melillo, and T. Peterson (Eds.) (2009) *Global Climate Change Impacts in the United States*. Cambridge University Press, Cambridge, United Kingdom.
- Karl, T.R., G.A. Meehl, T.C. Peterson, K.E. Kunkel, W.J. Gutowski, Jr., D.R. Easterling (2008) Executive Summary In: *Weather and Climate Extremes in a Changing Climate*. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands [T.R. Karl, G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.)]. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.
- Karl, T.R., S.J. Hassol, C.D. Miller, and W.L. Murray, eds. (2006). *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*. A report by the Climate Change Science Program and Subcommittee on Global Change Research.
- Kundzewicz, Z.W. et al. (2007) Freshwater Resources and Their Management. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Kunkel, K.E., P.D. Bromirski, H.E. Brooks, T. Cavazos, A.V. Douglas, D.R. Easterling, K.A. Emanuel, P. Ya. Groisman, G.J. Holland, T.R. Knutson, J.P. Kossin, P.D. Komar, D.H. Levinson, R.L. Smith (2008) Observed Changes in Weather and Climate Extremes. In: *Weather and Climate Extremes in a Changing Climate*. Regions

- of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands [T.R. Karl, G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.)]. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.
- Leibensperger, E. M., L. J. Mickley, D. J. Jacob (2008) Sensitivity of U.S. air quality to mid-latitude cyclone frequency and implications of 1980-2006 climate change, *Atmos. Chem. Phys.*, 8: 7075S7086.
- Lemke, K. et al. (2007) Observations: Changes in Snow, Ice and Frozen Ground. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Lettenmaier, D., D. Major, L. Poff, and S. Running (2008) Water Resources. In: *The effects of climate change on agriculture, land resources, water resources, and biodiversity*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global change Research. Washington, DC., USA, 362 pp.
- Liao, C. and Seinfeld (2006) Role of climate change in global predictions of future tropospheric ozone and aerosols, *J. Geophys. Res.*, 111, D12304, doi:10.1029/2005JD006852.
- McMichael et al. (2001). Human Health. In: *Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Mears, C.A., C.E. Forest, R.W. Spencer, R.S. Vose, R.W. Reynolds (2006) What is our understanding of the contributions made by observational or methodological uncertainties to the previously reported vertical differences in temperatures trends? In: *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences* [T.R. Karl, S.J. Hassol, C.D. Miller, and W.L. Murray (eds.)]. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.
- Meehl, G.A. et al. (2007) Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Mickley, L.J., D.J. Jacob, B.D. Field, and D. Rind (2004) Effects of future climate change on regional air pollution episodes in the United States. *Geophys. Res. Lett.*, 30, 1862, doi:10.1029/2003GL017933.
- Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.
- Mimura, N. et al. (2007) Small Islands. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- NARSTO (2004) *Particulate Matter Assessment for Policy Makers: A NARSTO Assessment* [P. McMurry, M. Shepherd, and J. Vickery (eds)]. Cambridge University Press, Cambridge, England. ISBN 0 52 184287 5.
- National Aeronautical and Space Administration (NASA) (2009) GISS Surface Temperature Analysis. <http://data.giss.nasa.gov/gistemp/2008/>. Accessed March 4, 2009.
- National Aeronautical and Space Administration (NASA) Goddard Space Flight Center (2008) 2008 Arctic Sea Ice from AMSR-E. <http://svs.gsfc.nasa.gov/vis/a000000/a003500/a003556/>. Accessed March 4, 2009.

- National Aeronautical and Space Administration (NASA) Goddard Space Flight Center (2007) 2007 Arctic Sea Ice from AMSR-E. <http://svs.gsfc.nasa.gov/vis/a000000/a003400/a003464/index.html>. Accessed March 4, 2009.
- National Intelligence Council (NIC) (2008) *Global Trends 2025: A Transformed World*. Office of the Director of National Intelligence, Washington DC, 120 pp.
- National Oceanic and Atmospheric Administration (NOAA) (2009a) *Global Surface Temperature Anomalies*. <http://www.ncdc.noaa.gov/oa/climate/research/anomalies/index.html>. Accessed September 24, 2009.
- National Oceanic and Atmospheric Administration (NOAA) (2009b) *State of the Climate Global Analysis- Annual 2008*. <http://www.ncdc.noaa.gov/sotc/?report=global&year=2008&month=13&submitted=Get+Report>. Accessed November 1, 2009.
- National Oceanic and Atmospheric Administration (NOAA) (2009c) *Trends in Atmospheric Carbon Dioxide - Mauna Loa*. <http://www.esrl.noaa.gov/gmd/ccgg/trends/>. Accessed March 4, 2009.
- National Oceanic and Atmospheric Administration (NOAA) (2009d). U.S. Historical Climate Network Version 2 Serial Monthly Dataset. <http://www.ncdc.noaa.gov/oa/climate/research/ushcn/>. Accessed November 1, 2009.
- National Oceanic and Atmospheric Administration (NOAA) (2009e). *2008 Annual Climate Review – National Overview*. <http://www.ncdc.noaa.gov/sotc/?report=national&year=2008&month=13&submitted=Get+Report>. Accessed November 1, 2009.
- National Research Council (NRC) (2008) *Potential Impacts of Climate Change on U.S. Transportation*. National Academy Press, Washington, DC.
- National Research Council (NRC) (2006a) *Mitigating Shore Erosion Along Sheltered Coasts*. National Academy Press, Washington, DC.
- National Research Council (NRC) (2006b) *Surface Temperature Reconstructions For the Last 2,000 Years*. National Academy Press, Washington, DC.
- National Research Council (2005) *Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties*. Committee on Radiative Forcing Effects on Climate, Climate Research Committee, ISBN: 0-309-54688-5.
- National Research Council (NRC) (2004) *Air Quality Management in the United States*. National Academy Press, Washington, DC.
- National Research Council (NRC) (2002) *Abrupt Climate Change. Inevitable Surprises*. National Academy Press, Washington, DC.
- National Research Council (NRC) (2001a) *Climate Change Science: An Analysis of Some Key Questions*. National Academy Press, Washington, DC.
- National Research Council (NRC) (2001b) *Global Air Quality: An Imperative for Long-Term Observational Strategies*. National Academy Press, Washington, DC.
- National Snow and Ice Data Center (NSIDC) (2009a) Characteristics: Arctic vs. Antarctic, <http://nsidc.org/seaice/characteristics/difference.html>. Accessed October 8, 2009.
- National Snow and Ice Data Center (NSIDC) (2009b) 2009 Arctic Sea Ice Minimum, http://nsidc.org/news/press/20091005_minimumpr.html. Accessed October 8, 2009.
- Nicholls, R.J. et al. (2007) Coastal Systems and Low-lying Areas. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental

- Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Parry, M.L. et al. (2007) Technical Summary. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)], Cambridge University Press, Cambridge, United Kingdom, pp. 235-78.
- Peterson, T. C., and M. O. Baringer (Eds.) (2009) State of the Climate in 2008. *Bull. Amer. Meteor. Soc.*, 90, S1-S196.
- Peterson, T.C., D.M. Anderson, S.J. Cohen, M. Cortez-Vázquez, R.J. Murnane, C. Parmesan, D. Phillips, R.S. Pulwarty, J.M.R. Stone, 2008: Why Weather and Climate Extremes Matter in Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. T.R. Karl, G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.). A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.
- Polyak, L., J. T. Andrews, J. Brigham-Grette, D. Darby, A. Dyke, S. Funder, M. Holland, A. Jennings, J. Savelle, M. Serreze, E. Wolff (2009) History of Sea Ice in the Arctic. In: *Past Climate Variability and Change in the Arctic and at High Latitudes*. A Report by the U.S. Climate Change Program and Subcommittee on Global Change Research. U.S. Geological Survey, Reston, VA, pp. 358-420.
- Randall, D.A., R.A. Wood, S. Bony, R. Colman, T. Fichefet, J. Fyfe, V. Kattsov, A. Pitman, J. Shukla, J. Srinivasan, R.J. Stouffer, A. Sumi, and K.E. Taylor (2007) *Climate Models and Their Evaluation*. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Rosenzweig, C., et al. (2007) Assessment of observed changes and responses in natural and managed systems. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, (eds.) Cambridge University Press, Cambridge, UK, pp. 79-131.
- Ryan, M., S. Archer, R. Birdsey, C. Dahm, L. Heath, J. Hicke, D. Hollinger, T. Huxman, G. Okin, R. Oren, J. Randerson, and W. Schlesinger (2008) Land Resources. In: *The effects of climate change on agriculture, land resources, water resources, and biodiversity*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.
- Schneider, S.H. et al. (2007) Assessing key vulnerabilities and the risk from climate change. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.), Cambridge University Press, Cambridge, UK, pp. 779-810.
- Schwartz, P. and D. Randall (2003) "An Abrupt Climate Change Scenario and Its Implications for United States National Security." Prepared for the Department of Defense by the Global Business Network.
- Scott, J.M., B. Griffith, R.S. Adamcik, D.M. Ashe, B. Czech, R.L. Fischman, P. Gonzalez, J.J. Lawler, A.D. McGuire, and A. Pidgorna (2008) National Wildlife Refuges. In: *Preliminary review of adaptation options for climate-sensitive ecosystems and resources*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Julius, S.H., J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, pp. 5-1 to 5-100.

- Sillman, S., and P. J. Samson (1995) Impact of temperature on oxidant photochemistry in urban, polluted rural and remote environments, *J. Geophys. Res.*, 100: 11,497–11,508.
- Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt (2007) Technical Summary. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Stevenson, D.S., et al. (2005) Impacts of climate change and variability on tropospheric ozone and its precursors. *Faraday Discuss.*, 130, doi:10.1039/b417412g.
- Trenberth, K.E. et al. (2007) Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- USDA (2007) *Crop Production Historical Track Records*, National Agricultural Statistics Service (NASS): <http://jan.mannlib.cornell.edu/usda/nass/htrcp//2000s/2007/htrcp-04-27-2007.pdf>.
- U.S. EPA (2009a) *Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone*. An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/094.
- U.S. EPA (2009b) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007*. EPA-430-R-09-004, Washington, DC.
- U.S. EPA, 2009c. 2005 Point Source National Emissions Inventory (NEI). U.S. Environmental Protection Agency, Emissions Monitoring and Analysis Division, Emission Inventory and Analysis Group, Research Triangle Park, North Carolina. <http://www.epa.gov/ttn/chieflnet/2005inventory.html>
- U.S. EPA (2008) National Air Quality: Status and Trends Through 2007. EPA-454/R-08-006, November 2008
- U.S. EPA (2006) *Air Quality Criteria for Ozone and Related Photochemical Oxidants*, EPA 600/R-05/004aF, February.
- U.S. EPA (2004) *Air Quality Criteria for Particulate Matter*, EPA/600/P-99/002aF, October.
- U.S. EPA (2002). Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency. Washington, DC: U.S. Environmental Protection Agency. EPA/260/R-02/008.
- U.S. EPA (1999) *1999 Update of Ambient Water Quality Criteria for Ammonia*, EPA-822-R-99-014.
- U.S. Navy (2001) *Naval Operations in an Ice-Free Arctic: Symposium*, Office of Naval Research, Naval Ice Center, April 17-18, 2001.
- Wigley, T.M.L., V. Ramaswamy, J.R. Christy, J.R. Lanzante, C.A. Mears, B.D. Santer, C.K. Folland (2006) Executive Summary in Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences [T. R. Karl, S. J. Hassol, C. D. Miller, and W. L. Murray (eds.)]. A Report by the

- Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.
- Wilbanks, T.J., P. Kirshen, D. Quattrochi, P. Romero-Lankao, C. Rosenzweig, M. Ruth, W. Solecki, and J. Tarr (2008) Effects of Global Change on Human Settlements. In: *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC, USA, pp. 3-1to 3-31.
- Wilbanks, T. et al. (2007) Industry, Settlement and Society. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- WMO (World Meteorological Organization) (2007) *Scientific Assessment of Ozone Depletion: 2006*, Global Ozone Research and Monitoring Project—Report No. 50, 572 pp., Geneva, Switzerland.
- WRI (2009) *Climate Analysis Indicators Tool (CAIT) Version 6.0*. Available at <http://cait.wri.org/>. Accessed August 5, 2009.

Appendix A: Brief Overview of Adaptation

Adaptation to climate change is the adjustment in the behavior or nature of a system to the effects of climate change. In the process of developing information to support the Administrator's decision regarding whether elevated combined greenhouse gas (GHG) concentrations endanger public health or welfare, various questions were raised about the relevance of adaptation. As noted in the Introduction, this document does not focus on adaptation because it (like GHG mitigation) is essentially a response to any known and/or perceived risks due to climate change. Although adaptation was not considered explicitly in the document, it does note where the underlying references already take into account certain assumptions about adaptation. This appendix provides a brief overview of the state of knowledge pertaining to adaptation.

What is Adaptation?

As defined in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007):

Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities.

Adaptations vary according to the system in which they occur; who undertakes them, the climatic stimuli that prompts them; and their timing, functions, forms, and effects. Adaptation can be of two broad types:

- Reactive or autonomous adaptation is the process by which species and ecosystems respond to changed conditions. An example is the northward migration of a species in response to increasing temperature.
- Anticipatory adaptation is planned and implemented before impacts of climate change are observed. An example is the construction of dikes in response to (and to prepare for) expected sea level rise.

Summary of the Scientific Literature on Adaptation

1. There is experience with adapting to weather, climate variability, and the current and projected impacts of climate change.

- There is a long record of practices to adapt to the impacts of weather, as well as natural climate variability. These practices include proactive steps like water storage and crop and livelihood diversification, as well as reactive or ex-post steps like emergency response, disaster recovery and migration.⁹¹
- The IPCC (2007) states—with very high confidence⁹²—that “Adaptation to climate change is already taking place, but on a limited basis.”⁹³

⁹¹ Adger et al. (2007), p. 720

⁹² A set of terms to describe uncertainties in current knowledge was used throughout IPCC's Fourth Assessment Report. On the basis of a comprehensive reading of the literature and their expert judgment, IPCC authors assigned a confidence level to major statements on the basis of their assessment of current knowledge, as follows:

- A wide array of adaptation options is available, ranging from purely technological (e.g., sea walls), through behavioral changes (e.g., altered food and recreational choices), to managerial (e.g., altered farm practices), and to policy (e.g., planning regulations).⁹⁴
 - Some programs have developed strategic plans for responding to climate change. An example is EPA's *National Water Program Strategy: Response to Climate Change* (U.S. EPA, 2008).
2. *Although adaptation options are known, available, and used in some places, there are significant barriers to their adoption.*
- The IPCC states with very high confidence that “there are substantial limits and barriers to adaptation.” These include formidable environmental, economic, informational, social, attitudinal, and behavioral barriers to the implementation of adaptation that are not fully understood.⁹⁵ The IPCC also states that there are significant knowledge gaps for adaptation, as well as impediments to flows of knowledge and information relevant to adaptation decisions.⁹⁶
3. *Current scientific information does not provide sufficient information to assess how effective current and future adaptation options will be at reducing vulnerability to the impacts of climate change. The fact that a country has a high capacity to adapt to climate change does not mean that its actions will be effective at reducing vulnerability.*
- While many technologies and adaptation strategies are known and developed in some countries, the available scientific literature does not indicate how effective various options are at fully reducing risks, particularly at higher levels of warming and related impacts, and for vulnerable groups.⁹⁷
 - High adaptive capacity does not necessarily translate into actions that reduce vulnerability. For example, despite a high capacity to adapt to heat stress through relatively inexpensive adaptations, residents in urban areas in some parts of the world, including European cities, continue to experience high levels of mortality.⁹⁸ To minimize the risks of heat stress domestically, EPA (2006) has worked collaboratively with other government agencies to provide guidance to municipalities on steps they can take to reduce heat-related morbidity and mortality.⁹⁹

Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than a 1 out of 10 chance

⁹³ Adger et al. (2007), p. 720

⁹⁴ *ibid*

⁹⁵ *ibid*

⁹⁶ Adger et al. (2007), p. 719

⁹⁷ *ibid*

⁹⁸ *ibid*

⁹⁹ Excessive Heat Events Guidebook (2006)

- Further research is needed to monitor progress on adaptation and to assess the direct as well as ancillary effects of adaptation measures.¹⁰⁰
- 4. *For any country—even one with high adaptive capacity—it is particularly difficult to reduce vulnerability for all segments of the population. The most vulnerable and difficult to reach populations are the elderly, children, and the poor.*
 - The IPCC states with very high confidence that “adaptive capacity is uneven across and within societies.” There are individuals and groups within all societies that have insufficient capacity to adapt to climate change.¹⁰¹
- 5. *More adaptation will be required to reduce vulnerability to climate change.¹⁰² Additional adaptation can potentially reduce, but is never expected to completely eliminate, vulnerability to current and future climate change.*
 - According to the IPCC, “adaptation alone is not expected to cope with all the projected effects of climate change, and especially not over the long term as most impacts increase in magnitude.”¹⁰³
- 6. *A portfolio of adaptation and mitigation measures can diminish the risks associated with climate change.*
 - Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts. Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed, and human systems to adapt.¹⁰⁴

¹⁰⁰ Adger et al. (2007) p. 737

¹⁰¹ Adger et al. (2007), p. 719

¹⁰² Adger et al. (2007), p. 719

¹⁰³ IPCC (2007), p. 19

¹⁰⁴ IPCC (2007), p. 20

References for Adaptation Appendix

- Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, (2007) Assessment of adaptation practices, options, constraints and capacity. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.) Cambridge University Press, Cambridge, United Kingdom, pp. 717-743.
- Excessive Heat Events Guidebook (2006). Report from the United States Environmental Protection Agency. 52 pages. June 2006. EPA 430-B-06-005.
- IPCC (2007) Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- U.S. EPA (2008) *National Water Program Strategy: Response to Climate Change*. Office of Water. EPA 800-R-08001, September.

Appendix B: Greenhouse Gas Emissions From Section 202(a) Source Categories

This Appendix provides greenhouse gas (GHG) emission information from Clean Air Act Section 202(a) source categories. It includes an overview of the respective source categories with a description of how the emission data from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* map to these source categories. Then, relevant emission data are presented and comparisons are made between U.S. GHG emissions from Section 202(a) source categories and domestic and global emission data. To inform the Administrator's assessment, the following types of comparisons for both the collective and individual emissions of GHGs from Section 202(a) source categories are provided:

- As a share of total global aggregate emissions of the well-mixed GHGs
- As a share of total U.S. aggregate emissions of the six GHGs
- As a share of the total global transportation emissions of the six GHGs

In addition, for each individual GHG, the following comparisons were also calculated:

- As a share of total U.S. Section 202(a) GHG emissions
- As a share of U.S. emissions of that individual GHG, including comparisons to the magnitude of emissions of that GHG from non-transport related source categories
- As a share of global emissions of that individual GHG
- As a share of global transport GHG emissions
- As a share of all global GHG emissions

(A) Overview of Section 202(a) Source Categories

To inform the Administrator's cause or contribute finding, EPA analyzed historical GHG emission data for motor vehicles and motor vehicle engines in the United States from 1990 to 2007 (the most recent year for which official EPA estimates are available). The motor vehicles and motor vehicle engines addressed include:

- Passenger cars
- Light-duty trucks
- Motorcycles
- Buses
- Medium/heavy-duty trucks

The source of the emissions data is the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (U.S. EPA, 2009)*. The *U.S. Inventory* is organized around the source classification scheme put forth by the Intergovernmental Panel on Climate Change, in which emissions from motor vehicles and motor vehicle engines are reported within two different sectors: Energy and Industrial Processes. Table B.1 describes the correspondence between Section 202(a) GHG emission source categories and IPCC source categories:

Table B.1: Source Categories Included Under Section 202(a)

Section 202(a) Source Category	IPCC Sector	IPCC Source Category	Greenhouse Gases
Passenger Cars	Energy	1A3b (i) Cars	CO ₂ , CH ₄ , N ₂ O
Light-Duty Trucks	Energy	1A3b (ii) Light-duty trucks	CO ₂ , CH ₄ , N ₂ O
Motorcycles	Energy	1A3b (iv) Motorcycles	CO ₂ , CH ₄ , N ₂ O
Buses	Energy	1A3b (iii) Heavy-duty trucks and buses	CO ₂ , CH ₄ , N ₂ O
Medium/Heavy-Duty Trucks	Energy	1A3b (iii) Heavy-duty trucks and buses	CO ₂ , CH ₄ , N ₂ O
Cooling (from section 202(a) sources)	Industrial Processes	2F1 Refrigeration and Air Conditioning Equipment	Hydrofluorocarbons (HFCs)

GHG emissions from aviation, pipelines, railways, and marine transport are included in the IPCC Energy Sector under 1A3 but are not included within Section 202(a).

(B) GHG Emissions from Section 202(a) Source Categories

(1) Total, combined GHG emissions from Section 202(a) source categories

Table B.2 presents historical emissions of all GHGs (CO₂, CH₄, N₂O, and HFCs) from Section 202(a) source categories from 1990-2007 in carbon dioxide equivalent units (TgCO₂e).¹⁰⁵ Passenger cars (38.7 percent), light-duty trucks (32.4 percent), and medium/heavy-duty trucks (24.8 percent) emitted the largest shares of GHG emissions in 2007, followed by cooling (from section 202(a) sources) (3.2 percent), buses (0.7 percent), and motorcycles (0.1 percent). From 1990 to 2007, GHG emissions from Section 202(a) source categories grew by 33.9 % due in part to increased demand for travel and the stagnation of fuel efficiency across the U.S. vehicle fleet. Since the 1970s, the number of highway vehicles registered in the United States has increased faster than the overall population, according to the Federal Highway Administration (FHWA).¹⁰⁶ Likewise, the number of miles driven (up 41.3% from 1990 to 2007) and the gallons of gasoline consumed each year in the United States have increased steadily since the 1980s, according to the FHWA and Energy Information

¹⁰⁵ A Tg is one teragram, or one million metric tons.

¹⁰⁶ FHWA (1996 through 2008) Highway Statistics. Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Report FHWA-PL-96-023-annual. Available online at <<http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm>>.

Administration, respectively.¹⁰⁷ These increases in motor vehicle use are the result of a confluence of factors, including population growth, economic growth, urban sprawl, low fuel prices, and increasing popularity of sport utility vehicles and other light-duty trucks that tend to have lower fuel efficiency.

¹⁰⁷ DOE (1993 through 2008) Transportation Energy Data Book. Office of Transportation Technologies, Center for Transportation Analysis, Energy Division, Oak Ridge National Laboratory. ORNL-5198.

Table B.2: Total Greenhouse Gas Emissions by Section 202(a) Source Category (Tg CO₂e)

Section 202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	656.9	633.9	670.3	673.1	686.5	664.4	660.7	677.3	651.1	639.6
Light-Duty Trucks	336.2	428.6	489.7	492.9	502.9	536.5	557.3	517.1	528.8	533.8
Motorcycles	1.8	1.8	1.9	1.7	1.7	1.7	1.8	1.7	1.9	2.1
Buses	8.3	9.0	10.9	10.0	9.7	10.5	14.7	11.8	12.1	12.1
Medium/Heavy-Duty Trucks	228.8	272.4	342.7	341.8	355.9	352.3	365.0	392.9	402.3	408.6
Cooling (from section 202(a) sources)	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2
Total	1231.9	1362.1	1538.5	1566.3	1606.6	1617.7	1654.6	1657.3	1652.1	1649.3

Between 1990 and 2007, GHG emissions from passenger cars decreased 2.6%, though there was some growth in GHG emissions from 2000 to 2002, and again from 2004 to 2005. Emissions from light-duty trucks increased 58.8% from 1990 to 2007, largely due to the increased use of sport-utility vehicles and other light-duty trucks. Meanwhile, GHG emissions from heavy-duty trucks increased 78.6%, reflecting the increased volume of total freight movement and an increasing share transported by trucks. In 1990, there were no hydrofluorocarbons (HFCs) used in vehicle cooling systems. HFCs were gradually introduced into motor vehicle air conditioning and refrigerating systems during the 1990s as chlorofluorocarbons (CFCs), and hydrochlorofluorocarbons (HCFCs) started to phase out of production as required under the Montreal Protocol and Title VI of the Clean Air Act.

Table B.3 presents GHG emissions from Section 202(a) source categories alongside total U.S. emissions. The table also presents emissions from the electricity generation and industrial sectors for comparison. In 1990, Section 202(a) source categories emitted 20.2% of total U.S. emissions, behind the electricity generation sector (30.5%) and the industrial sector (24.5%). By 2007, Section 202(a) source categories collectively were the second largest sector with 23.1% of total U.S. emissions, due both to growth in vehicle emissions and a decline in emissions from industry.

Table B.3: Sectoral Comparison to Total U.S. Greenhouse Gas Emissions (Tg CO₂e)

U.S. Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) GHG emissions	1231.9	1362.1	1558.5	1566.3	1606.6	1617.7	1654.6	1657.3	1652.1	1649.3
Share of U.S. (%)	20.2%	21.1%	22.2%	22.7%	23.1%	23.2%	23.4%	23.3%	23.4%	23.1%
Electricity sector emissions	1859.1	1989.0	2329.3	2292.1	2301.1	2329.6	2362.0	2429.4	2375.5	2445.1
Share of U.S. (%)	30.5	30.8	33.2	33.2	33.1	33.4	33.4	34.2	33.7	34.2
Industrial sector emissions	1496.0	1524.5	1467.5	1415.0	1418.4	1394.7	1408.7	1364.9	1388.4	1386.3
Share of U.S. (%)	24.5	23.6	20.9	20.5	20.4	20.0	19.9	19.2	19.7	19.4
Total U.S. GHG emissions	6098.7	6463.3	7008.2	6896.3	6942.3	6981.1	7064.9	7108.6	7051.1	7150.1

Table B.4 compares total GHG emissions from Section 202(a) source categories to all U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), and total global GHG emissions from all source categories, for 2005.¹⁰⁸ Section 202(a) GHG emissions are a significantly larger share of global transport GHG emissions (28.0%) than the corresponding share of all U.S. GHG emissions to the global total (18.4%), reflecting the relative size of the transport sector in the United States compared to the global average. Section 202(a) GHG emissions were 4.3% of total global emissions in 2005. The global transport sector was 15.3% of all global emissions in 2005.

¹⁰⁸ The year 2005 is the most recent year for which comprehensive greenhouse gas emissions data are available for all gases, all countries, and all sources. Global estimates are "gross" emissions estimates and do not include removals of greenhouse gas emissions from the atmosphere by terrestrial sinks (i.e., forests and other biomass). Global data come from the World Resources Institute's Climate Analysis Indicators Tool, which contains national data submitted by Parties to the UNFCCC, and other independent and peer-reviewed datasets (e.g., International Energy Agency).

Table B.4: Comparison to Global Greenhouse Gas Emissions (Tg CO₂e)

	2005	Sec 202(a) Share
All U.S. GHG emissions	7,109	23.3%
Global transport GHG emissions	5,925	28.0%
All global GHG emissions	38,726	4.3%

(2) Individual GHG emissions from Section 202(a) source categories

Table B.5 presents total GHG emissions from Section 202(a) source categories by gas, in CO₂ equivalent units. In 2007, CO₂ made up the largest share of emissions (95.1%), followed by HFCs (3.2%), N₂O (1.6%) and CH₄ (0.1%). Since 1990, the share of HFCs has increased (from zero in 1990), whereas the share of the other gases has correspondingly decreased. Methane and N₂O emissions have decreased in absolute terms since 1990.

Table B.5: Greenhouse Gas Emissions From Section 202(a) Source Categories by Gas (Tg CO₂e)

Section 202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
CO ₂	1187.3	1291.9	1463.8	1470.5	1512.0	1524.2	1561.4	1566.2	1564.9	1568.5
Share of Sec 202 GHGs	96%	95%	94%	94%	94%	94%	94%	95%	95%	95%
CH ₄	4.2	3.8	2.9	2.8	2.4	2.2	2.1	1.9	1.8	1.7
Share of Sec 202 GHGs	0.34%	0.28%	0.18%	0.18%	0.15%	0.14%	0.13%	0.12%	0.11%	0.10%
N ₂ O	40.4	50.1	48.8	46.4	42.3	38.9	36.1	32.7	29.5	26.0
Share of Sec 202 GHGs	3.3%	3.7%	3.1%	3.0%	2.6%	2.4%	2.2%	2.0%	1.8%	1.6%
HFCs	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2
Share of Sec 202 GHGs	0.0%	1.2%	2.8%	3.0%	3.1%	3.2%	3.3%	3.4%	3.4%	3.2%
Total GHGs	1231.9	1362.1	1558.5	1566.3	1606.6	1617.7	1654.6	1657.3	1652.1	1649.3

(a) Carbon dioxide emissions from Section 202(a) source categories

Carbon dioxide is emitted from motor vehicles and motor vehicle engines during the fossil fuel combustion process. During combustion, the carbon (C) stored in the fuels is oxidized and emitted as CO₂ and smaller amounts of other carbon compounds, including CH₄, carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). These other C-containing non-CO₂ gases are emitted as by-products of incomplete fuel combustion, but are, for the most part, eventually oxidized to CO₂ in the atmosphere.

As the dominant GHG emitted from motor vehicles and motor vehicle engines (95.1% of total emissions in 2007), CO₂ emission trends in Table B.6 mirror those of the GHG emission total. Carbon dioxide emissions grew by 32.1% between 1990 and 2007. Most of this growth occurred as a result of increased CO₂ emissions from light-duty trucks (62.8%) and medium/heavy-duty trucks (78.8%). Emissions from passenger cars did not grow over the same time period.

Table B.6: CO₂ Emissions by Section 202(a) Source Category (Tg CO₂)

Sec. 202 Source Categories	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	628.8	604.9	643.5	647.9	662.6	642.1	640.0	658.4	634.4	625.0
Light-Duty Trucks	320.7	405.0	466.2	470.5	483.5	519.1	541.2	502.8	515.5	522.0
Motorcycles	1.7	1.8	1.8	1.7	1.7	1.6	1.7	1.6	1.9	2.0
Buses	8.3	9.0	10.9	10.0	9.6	10.5	14.7	11.8	12.1	12.0
Medium/Heavy-Duty Trucks	227.8	271.2	341.3	340.4	354.5	350.8	363.7	391.6	401.1	407.4
Cooling (from section 202(a) sources)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	1187.3	1291.9	1463.8	1470.5	1512.0	1524.2	1561.4	1566.2	1564.9	1568.5

Table B.7 presents CO₂ emissions from Section 202(a) source categories alongside total U.S. CO₂ emissions. The table also presents emissions from the electricity generation and industrial sectors for comparison. In 1990, Section 202(a) source categories emitted 23.4% of total U.S. CO₂ emissions, behind the electricity generation sector (36.0%), and ahead of the industrial sector (22.3%). By 2007, emissions from Section 202(a) source categories increased to 25.7% of total U.S. CO₂ emissions.

Table B.7: Sectoral Comparison to Total U.S. CO₂ Emissions (Tg CO₂)

U.S. CO ₂ Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202 CO ₂ emissions	1187.3	1291.9	1463.8	1470.5	1512.0	1524.2	1561.4	1566.2	1564.9	1568.5
Share of U.S. CO ₂ (%)	23.4%	23.9%	24.6%	25.1%	25.6%	25.6%	25.8%	25.7%	26.0%	25.7%
Electricity Sector CO ₂	1829.7	1964.2	2311.7	2274.6	2284.0	2313.6	2345.0	2412.0	2358.3	2429.4
Share of U.S. CO ₂ (%)	36.0	36.3	38.8	38.8	38.7	38.8	38.8	39.6	39.2	39.8
Industrial Sector CO ₂	1132.6	1176.5	1148.6	1119.7	1122.5	1111.6	1130.4	1100.3	1126.0	1115.7
Share of U.S. CO ₂ (%)	22.3	21.8	19.3	19.1	19.0	18.6	18.7	18.1	18.7	18.3
Total U.S. CO ₂ emissions	5076.7	5407.9	5955.2	5860.0	5908.2	5963.2	6048.1	6090.8	6014.9	6103.4

Table B.8 compares total CO₂ emissions from Section 202(a) source categories to total U.S. emissions, global GHG emissions from the transport sector (as defined by IPCC), and total global GHG emissions from all source categories, for 2005. Section 202(a) CO₂ emissions are a significantly larger share of global transport GHG emissions (26.4%) than the corresponding share of all U.S. CO₂ emissions to the global total (22.0%), reflecting the relative size of the transport sector in the U.S. compared to the global average. Section 202(a) CO₂ emissions were 4.0% of total global GHG emissions in 2005.

Table B.8: Comparison to U.S. and Global Greenhouse Gas Emissions (Tg CO₂e)

Global Emissions	2005	Sec 202(a) CO ₂ Share
All U.S. GHG emissions	7,109	22.0%
All global CO ₂ emissions	27,526	5.7%
Global transport GHG emissions	5,925	26.4%
All global GHG emissions	38,726	4.0%

(b) Methane emissions from Section 202(a) source categories

Methane emissions from motor vehicles are a function of the CH₄ and hydrocarbon content of the motor fuel, the amount of hydrocarbons passing uncombusted through the engine, and any post-combustion control of hydrocarbon emissions (such as catalytic converters).

Table B.9 shows the trend in CH₄ emissions from Section 202(a) source categories since 1990, presented in carbon dioxide equivalents. The combustion of gasoline in passenger cars and light-duty trucks was responsible for the majority (91.2%) of the CH₄ emitted from Section 202(a) source categories. From 1990 to 2007, CH₄ emissions decreased by 61%.

Table B.9: CH₄ Emissions by Section 202(a) Source Category (Tg CO₂e)

202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	2.6	2.1	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9
Light-Duty Trucks	1.4	1.4	1.1	1.1	0.9	0.8	0.7	0.7	0.7	0.6
Motorcycles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Medium/Heavy-Duty Trucks	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cooling (from section 202(a) sources)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	4.2	3.8	2.9	2.8	2.4	2.2	2.1	1.9	1.8	1.7

Table B.10 presents CH₄ emissions from Section 202(a) source categories alongside total U.S. CH₄ emissions. The table also presents CH₄ emissions from landfills and natural gas systems for comparison. In 2007, Section 202(a) source categories emitted 0.3% of total U.S. CH₄ emissions; landfills (22.7%) and natural gas systems (17.9%) represented a significantly larger share. Overall, total U.S. CH₄ emissions decreased by 5.1% (31.3 TgCO₂e) from 1990 to 2007, in part due to efforts to reduce emissions at individual sources such as landfills and coal mines.

Table B.10: Sectoral Comparison to Total U.S. CH₄ Emissions (Tg CO₂e)

U.S. CH ₄ Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) CH ₄ emissions	4.2	3.8	2.9	2.8	2.4	2.2	2.1	1.9	1.8	1.7
Share of U.S. CH ₄ (%)	0.69	0.62	0.48	0.48	0.42	0.39	0.37	0.34	0.31	0.28
Landfill CH ₄ emissions	149.2	144.3	122.3	119.5	121.9	128.3	126.2	127.8	130.4	132.9
Share of U.S. CH ₄ (%)	24.2	23.4	20.7	20.7	21.0	22.2	22.4	22.8	22.4	22.7
Natural Gas CH ₄ emissions	129.6	132.6	130.8	129.5	129.0	127.2	118.0	106.3	104.8	104.7
Share of U.S. CH ₄ (%)	21.0	21.5	22.1	22.4	22.2	22.0	21.0	18.9	18.0	17.9
Total U.S. CH ₄ emissions	616.6	615.8	591.1	577.1	580.9	578.7	562.7	561.7	582.0	585.3

Table B.11 compares total CH₄ emissions from Section 202(a) source categories to U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), and total global GHG emissions from all source categories, for 2005. Section 202(a) CH₄ emissions are a significantly smaller share of U.S., global transport, and global emissions in comparison to Section 202(a) CO₂ emissions.

Table B.11: Comparison to US and global greenhouse gas emissions (Tg CO₂e)

Global Emissions	2005	Sec 202(a) CH ₄ Share
All U.S. GHG emissions	7,109	0.03%
All global CH ₄ emissions	6,408	0.03%
Global transport GHG emissions	5,925	0.03%
All global GHG emissions	38,726	0.005%

(c) Nitrous oxide emissions from Section 202(a) source categories

Nitrous oxide (N₂O) is a product of the reaction that occurs between nitrogen and oxygen during fuel combustion. N₂O emissions from motor vehicles and motor vehicle engines are closely related to fuel characteristics, air-fuel mixes, combustion temperatures, and the use of pollution control equipment. For example, some types of catalytic converters installed to reduce motor vehicle NO_x, CO, and hydrocarbon emissions can promote the formation of N₂O.

Table B.12 shows the trend in N₂O emissions from Section 202(a) source categories since 1990, presented in carbon dioxide equivalents. Section 202(a) emissions of N₂O decreased by 35.55% from 1990 to 2007. Earlier generation control technologies initially resulted in higher N₂O emissions, causing a 24.2% increase in N₂O emissions from motor vehicles between 1990 and 1995. Improvements in later-generation emission control technologies have reduced N₂O output, resulting in a 48.1% decrease in N₂O emissions from 1995 to 2007. Overall, Section 202(a) N₂O emissions were predominantly from gasoline-fueled passenger cars (52.8%) and light-duty trucks (42.8%) in 2007.

Table B.12: N₂O Emissions by Section 202(a) Source Category (Tg CO₂e)

202(a) Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Passenger Cars	25.4	26.9	25.2	23.8	22.5	21.0	19.5	17.8	15.7	13.7
Light-Duty Trucks	14.1	22.1	22.4	21.3	18.5	16.6	15.3	13.7	12.6	11.1
Motorcycles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Medium/Heavy-Duty Trucks	0.8	1.0	1.2	1.2	1.3	1.3	1.2	1.2	1.1	1.1
Cooling (from section 202(a) sources)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	40.4	50.1	48.8	46.4	42.3	38.9	36.1	32.7	29.5	26.0

Table B.13 presents N_2O emissions from Section 202(a) source categories alongside total U.S. N_2O emissions. The table also presents N_2O emissions from agricultural soil management and nitric acid production for comparison. In 2007, Section 202(a) source category emitted 8.3% of total United States N_2O emissions, making it the second largest source category. By far the largest source category in the United States is agricultural soil management, representing 66.7% of total N_2O emissions in 2007. The third largest source in 2007 was nitric acid production (7.0%).

Table B.13: Sectoral Comparison to Total U.S. N_2O Emissions (Tg CO_2e)

U.S. N_2O Emissions Section 202(a) N_2O emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	40.4	50.1	48.8	46.4	42.3	38.9	36.1	32.7	29.5	26.0
Share of U.S. N_2O (%)	12.8	15.0	14.8	13.8	13.1	12.5	11.4	10.3	9.4	8.3
Agricultural Soil N_2O emissions	200.3	202.3	204.5	220.4	207.6	202.8	211.2	210.6	208.4	207.9
Share of U.S. N_2O (%)	63.6	60.6	62.1	65.5	64.5	64.9	66.4	66.7	66.8	66.7
Nitric Acid N_2O emissions	20.0	22.3	21.9	17.8	19.3	18.1	18.0	18.6	18.2	21.7
Share of U.S. N_2O (%)	6.3	6.7	6.7	5.3	6.0	5.8	5.6	5.9	5.8	7.0
Total U.S. N_2O emissions	315.0	334.1	329.2	336.5	322.0	312.5	317.8	315.9	312.1	311.9

Table B.14 compares total N₂O emissions from Section 202(a) source categories to U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), total global N₂O emissions, and total global GHG emissions from all source categories, for 2005. Section 202(a) N₂O emissions are just under 0.55% of global transport emissions and 0.08% of all global GHG emissions.

Table B.14: Comparison to U.S. and Global Greenhouse Gas Emissions (Tg CO₂e)

	2005	Sec 202(a) N ₂ O Share
All U.S. GHG emissions	7,109	0.46%
All global N ₂ O emissions	3,286	0.99%
Global transport GHG emissions	5,925	0.55%
All global GHG emissions	38,726	0.08%

(d) HFC emissions from Section 202(a) source categories

HFCs (a term that encompasses a group of 11 related compounds) are progressively replacing CFCs and HCFCs in Section 202(a) cooling and refrigeration systems as they are being phased out under the Montreal Protocol and Title VI of the Clean Air Act.¹⁰⁹ For example, HFC-134a has become a replacement for CFC-12 in mobile air conditioning systems. A number of HFC blends, containing multiple compounds, have also been introduced. The emission pathway can be complex, with HFCs being emitted to the atmosphere during the charging, operation, and decommissioning/disposal of cooling and refrigeration system.

Table B.15 shows the trend in HFC emissions from Section 202(a) source categories since 1990, presented in carbon dioxide equivalents. As opposed to the GHGs discussed above, estimates of HFC emissions are presented here as the sum of HFC emissions from all vehicle modes that qualify as section 202(a) source categories. This was done because the *U.S. Inventory* does not disaggregate HFC emission data into vehicle types in exactly the same way as it does for other GHGs. The vehicle modes that are included in the HFC emission estimates are passenger cars, light-duty trucks and buses. Additionally, while HFC emissions associated with comfort cooling for passengers in medium and heavy duty trucks are considered a section 202(a) source, these emissions are not included here because they are not estimated for the *U.S. Inventory* due to insufficient data. As such, the numbers presented here are likely a slight underestimate of total section 202(a) HFC emissions. HFCs were not used in motor vehicles in 1990, but by 2007 emissions had increased to 53.2 Tg CO₂e. From 1995 to 2007, HFC emissions from Section 202(a) source categories increased by 227%.

¹⁰⁹ 2006 IPCC Guidelines, Volume 3, Chapter 7, Page 43 (IPCC, 2006a).

Table B.15: HFC Emissions by Section 202(a) Source Category (Tg CO₂e)

202(a) HFC Sources	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Cooling (from section 202(a) sources)	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2

Table B.16 presents HFC emissions from Section 202(a) source categories alongside total U.S. HFC emissions. The table also presents HFC emissions from HCFC-22 production and all other end-use applications of substitutes for ozone-depleting substances (ODS substitutes) for comparison. In 2007, Section 202(a) source categories emitted 42.4% of total U.S. HFC emissions, making it the largest source category. Other applications of ODS substitutes (including foam blowing, fire protection, aerosol propellants, solvents, and other applications) accounted for 44.1%. HCFC-22 chemical production results in byproduct releases of HFC-23, which accounted for 98.6% of HFC emissions in 1990, but declined by 2007 and now represents 13.5%.

Table B.16: Sectoral Comparison to Total U.S. HFC Emissions (Tg CO₂e)

U.S. HFC Emissions	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Section 202(a) HFC emissions	0.0	16.2	43.0	46.7	49.9	52.4	55.1	56.5	55.9	53.2
Share of U.S. HFC (%)	0	26	43	48	48	52	49	49	46.9	42.4
HCFC-22 Production	36.4	33.0	28.6	19.7	21.1	12.3	17.2	15.8	13.8	17.0
Share of U.S. HFC (%)	98.6	53.4	28.6	20.4	20.2	12.1	15.3	13.6	11.6	13.5
Other ODS Substitutes	0.5	12.6	28.5	30.4	33.3	36.7	40.1	43.8	49.4	55.4
Share of U.S. HFC (%)	1.4	20.4	28.5	31.4	31.9	36.2	35.7	37.7	41.5	44.1
Total U.S. HFC emissions	36.9	61.8	100.1	96.9	104.3	101.4	112.4	116.1	119.1	123.5

Table B.17 compares total HFC emissions from Section 202(a) source categories to U.S. GHG emissions, global GHG emissions from the transport sector (as defined by IPCC), total global HFC emissions, and total global GHG emissions from all source categories, for 2005. Section 202(a) HFC emissions are 0.95% of global transport emissions and 0.15% of all global GHG emissions, but actually make up 14.8% of global HFC emissions.

Table B.17: Comparison to U.S. and Global Greenhouse Gas Emissions (Tg CO₂e)

	2005	Sec 202(a) HFC Share
All U.S. GHG emissions	7,109	0.79%
All global HFC emissions	381	14.8%
Global transport GHG emissions	5,925	0.95%
All global GHG emissions	38,726	0.15%

(e) PFC and SF₆ emissions

Perfluorocarbons (PFCs) are not emitted from motor vehicles or motor vehicle engines in the United States. The main sources of PFC emissions in the United States are aluminum smelting and semiconductor manufacturing.

Similarly, sulfur hexafluoride (SF₆) is not emitted from motor vehicles or motor vehicle engines in the United States, although use of SF₆ for tire inflation has been reported in other countries.¹¹⁰ The main sources of SF₆ emissions in the United States are electrical transmission and distribution systems and primary magnesium smelting.

¹¹⁰ 2006 IPCC Guidelines, Volume 3, Chapter 8 (IPCC, 2006b).

References for Appendix B

- DOE (1993 through 2008) Transportation Energy Data Book. Office of Transportation Technologies, Center for Transportation Analysis, Energy Division, Oak Ridge National Laboratory. ORNL-5198.
- FHWA (1996 through 2008) Highway Statistics. Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Report FHWA-PL-96-023-annual. Available online at <http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm>.
- IPCC (2006a) Emissions of Fluorinated Substitutes for Ozone Depleting Substances (Chapter 7), Industrial Processes (Volume 3) In: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.
- IPCC (2006b) Other Product Manufacture and Use (Chapter 8), Industrial Processes (Volume 3) In: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.
- U.S. EPA (2009) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2007*. EPA-430-R-09-004-004, Washington, DC.
- WRI (2009) *Climate Analysis Indicators Tool (CAIT) Version 6.0*. Available at <http://cait.wri.org/>. Accessed August 5, 2009.

Appendix C: Direct Effects of Ambient GHG Concentrations on Human Health

Greenhouse gases (GHG), at both current and projected atmospheric concentrations, are not expected to pose exposure risks on human respiratory systems (i.e., breathing/inhalation). The literature supporting this conclusion is described below.

Carbon dioxide (CO₂)

The direct effects of high CO₂ concentrations on human health were assessed in the EPA (2000a) report, *Carbon Dioxide as a Fire Suppressant: Examining the Risks*, and have also been reviewed by the IPCC (2005) *Special Report on Carbon Dioxide Capture and Storage*. At concentrations above about 2%, CO₂ has a strong effect on respiratory physiology, and at concentrations above 7 to 10%, it can cause unconsciousness and death (IPCC, 2005). Exposure studies have not revealed any adverse health effect of chronic exposure to concentrations below 1%. At concentrations greater than 17%, loss of controlled and purposeful activity, unconsciousness, convulsions, coma, and death occur within one minute of initial inhalation of CO₂ (OSHA, 1989; CCOHS, 1990; Dalgaard et al., 1972; CATAMA, 1953; Lambertsen, 1971). But CO₂ is a physiologically active gas and is a normal component of blood gases (U.S. EPA, 2000b). Acute CO₂ exposure of up to 1% and 1.5% by volume is tolerated quite comfortably (U.S. EPA, 2000b).

The ambient concentration of CO₂ in the atmosphere is presently about 0.039% by volume (or 386 ppm). Projected increases in CO₂ concentrations from anthropogenic emissions range from 41 to 158% above 2005 levels (of about 380 ppm) or 535 to 983 ppm by 2100 (Meehl et al., 2007) (see Section 5). Such increases would result in atmospheric CO₂ concentrations of 0.054 to 0.098% by volume in 2100, which is well below published thresholds for adverse health effects.

Methane (CH₄)

CH₄ is flammable or explosive at concentrations of 5 to 15% by volume (50,000 to 150,000 ppm) of air (NIOSH, 1994; NRC, 2000). At high enough concentrations, CH₄ is also a simple asphyxiant, capable of displacing enough oxygen to cause death by suffocation. Threshold limit values are not specified because the limiting factor is the available oxygen (NRC, 2000). Atmospheres with oxygen concentrations below 19.5% can have adverse physiological effects, and atmospheres with less than 16% oxygen can become life threatening (MSHA, 2007). Methane displaces oxygen to 18% in air when present at 14% (140,000 ppm).

When oxygen is readily available, CH₄ has little toxic effect (NRC, 2000). In assessing emergency exposure limits for CH₄, the NRC (2000) determined that an exposure limit that presents an explosion hazard cannot be recommended, even if it is well below a concentration that would produce toxicity. As such, it recommended an exposure limit of 5,000 ppm for methane (NRC, 2000). The National Institute for Occupational Health Safety (NIOSH, 1994) established a threshold limit value (TLV) for methane at 1,000 ppm.

The current atmospheric concentration of CH₄ is 1.78 ppm. The projected CH₄ concentration in 2100 ranges from 1.46 to 3.39 ppm by 2100, well below any recommended exposure limits (Meehl et al., 2007).

Nitrous Oxide (N₂O)

N₂O is an asphyxiant at high concentrations. At lower concentrations, exposure causes central nervous system, cardiovascular, hepatic (pertaining to the liver), hematopoietic (pertaining to the formation of blood or blood cells), and reproductive effects in humans (Hathaway et al., 1991). At a concentration of 50 to 67% (500,000 to 670,000 ppm) N₂O is used to induce anesthesia in humans (Rom, 1992).

NIOSH has established a recommended exposure limit (REL) for N₂O of 25 ppm as a time-weighted average (TWA) for the duration of the exposure (NIOSH, 1992). The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned N₂O a TLV of 50 ppm as a TWA for a normal 8-hour workday and a 40-hour workweek (ACGIH, 1994).

The NIOSH limit is based on the risk of reproductive system effects and decreases in audiovisual performance (NIOSH, 1992). The ACGIH limit is based on the risk of reproductive, hematological (related to the study of the nature, function, and diseases of the blood and of blood-forming organs), and nervous system effects (ACGIH, 1994).

The current atmospheric concentration of N₂O is 0.32 ppm. The projected N₂O concentration in 2100 ranges from 0.36 to 0.46 ppm., well below any exposure limits (Meehl et al., 2007).

Fluorinated Gases (HFCs, PFCs, SF₆)

Most fluorinated gases emitted from anthropogenic activities are released in very small quantities relative to established thresholds for adverse health outcomes from exposure. The health effects of exposure to one illustrative HFC gas, one illustrative HCFC gas, and sulfur hexafluoride (SF₆) are given in the context of their current atmospheric concentration. Chlorofluorocarbons are not included in this discussion given their phaseout under the Montreal Protocol.

The NRC (1996) recommended a 1-hour emergency exposure guidance level (EEGL) of 4,000 ppm for HFC-134a. This recommendation was based on a no-observed-adverse-effect level of 40,000 ppm in cardiac-sensitization tests of male beagles (NRC, 1996). It recommended 24-hour EEGL of 1,000 ppm based on the fetotoxicity effects (slight retardation of skeletal ossification) observed in rats exposed to HFC-134a. Finally, it recommended a 90-day Continuous Exposure Guidance Level (CEGL) of 900 ppm based on a two-year chronic toxicity study conducted in male rats exposed to HFC-134a at different concentrations for six hours/day, five days/week. The atmospheric concentration of HFC 134a in 2003 was in the range of 26 to 31 parts per trillion according to IPCC/TEAP (2005), many orders of magnitude below EEGLs.

For HCFC-123, the end points of pharmacological or adverse effects considered for establishing an EEGL are cardiac sensitization, anesthesia or CNS-related effects, malignant hyperthermia, and hepatotoxicity. According to the NRC (1996), the concentration required to produce cardiac sensitization in 50% of the animals for HCFC-123 was determined in dog studies to be 1.9% (19,000 ppm) for a 5-minute exposure. The NRC recommended that 1,900 ppm (19,000 ppm divided by an uncertainty factor of 10 for interspecies variability) should be considered the human no-observed-effect level for a 1-minute exposure to HCFC-123 on the basis of the dog cardiac-sensitization model. The concentration of HCFC-123 in 1996 was 0.03 parts per trillion according to IPCC/TEAP (2005), many orders of magnitude below the established effect level.

SF₆ is a relatively nontoxic gas but an asphyxiant at high concentrations. The NIOSH recommended exposure limit is 1,000 ppm (NIOSH, 1997). The SF₆ concentration in 2003 was about 5 parts per trillion according to IPCC/TEAP (2005), many orders of magnitude below the exposure limit.

References for Appendix C

- ACGIH (1994) 1994-1995 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
- CATAMA (1953) *Aviation Toxicology -- an Introduction to the Subject and a Handbook of Data*. Committee on Aviation Toxicology, Aero Medical Association. The Blakiston Co.: New York, NY. pp. 6S9, 31S39, 52S55, 74S79, 110S115.
- CCOHS (Canadian Centre for Occupational Health and Safety). 1990. CHEMINFO database search.
- Dalgaard, J.B., G. Dencker, B. Fallentin, P. Hansen, B. Kaempe, J. Steensberger, Willhardt, P. (1972) Fatal poisoning and other health hazards connected with industrial fishing. *Br. J. Ind. Med.* 29: 307S316.
- Hathaway GJ, NH Proctor, JP Hughes, and ML Fischman (1991) *Proctor and Hughes' chemical hazards of the workplace*. 3rd ed. New York, NY: Van Nostrand Reinhold.
- IPCC (2005) Special Report on Carbon Dioxide Capture and Storage. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change.
- IPCC Technology and Economic Assessment Panel (2005) IPCC/TEAP Special Report on Safe-guarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons. Prepared by Working Group I and III of the IPCC, and the TEAP [B. Metz, L. Kuijpers, S. Solomon, S.O. Andersen, O. Davidson, J. Pons, D. de Jager, T. Kestin, M. Manning, and L.A. Meyers (eds.), Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 488 pp.
- Lambertsen, C.J. (1971) "Therapeutic Gases—Oxygen, Carbon Dioxide, and Helium." Drill's Pharmacology in Medicine. Chapter 556, [J.R. DiPalma (ed)], McGraw-Hill Book Co.: New York, NY.
- Meehl, G.A. et al. (2007) Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Mine Safety and Health Administration (MSHA) (2007) *The Danger of Oxygen Deficiency in Underground Coal Mines*. Department of Labor Program Information Bulletin NO. P07-05. <http://www.msha.gov/regs/compliance/PIB/2007/pib07-05.asp>.
- NIOSH (1997) NIOSH Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Washington, D.C. NIOSH Publication no. 97-140; NTIS no. PB-97177604. <http://www.cdc.gov/niosh/npg/npgd0576.html>.
- NIOSH (1994) International Chemical Safety Cards—Methane. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Washington, D.C. <http://www.cdc.gov/niosh/ipcsneng/neng0291.html>.
- NIOSH (1992) Recommendations for occupational safety and health: Compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (NIOSH) Publication No. 92-100.
- National Research Council (NRC) (2000) *Emergency and Continuous Exposure Limits for Selected Airborne Contaminants*, Volume I. National Academy Press, Washington, D.C.

- National Research Council (NRC) (1996) *Toxicity of Alternatives to Chlorofluorocarbons: HFC-134a and HCFC-123*. National Academy Press, Washington, D.C.
- OSHA (1989) *Carbon Dioxide. Industrial Exposure and Control Technologies for OSHA Regulated Hazardous Substances*, Volume I of II, Substance A - I. Occupational Safety and Health Administration. Washington, DC: U.S. Department of Labor. March.
- Rom, WN (1992) *Environmental and occupational medicine*. 2nd ed. Boston, MA: Little, Brown and Company.
- U.S. EPA (2000a) *Carbon Dioxide as a Fire Suppressant: Examining the Risks*, EPA 430-R-00-002, May.
- U.S. EPA (2000b) *Carbon Dioxide as a Fire Suppressant: Examining the Risks, Appendix B – Overview of Acute Health Effects*, EPA 430-R-00-002, May.

Senator BOXER. So there is an endangerment finding, so for people to sit here and say it is no danger is simply contradicted by the facts and by science.

I also want to ask you a couple things here. There is an attempt now to blame all the clean air regulations, blame them on this rogue employee who is now in jail. Is it not true that any kind of proposed rule goes through public comment, peer review, inter-agency review, and is subjected to judicial review? Is that not so?

Ms. MCCARTHY. That is correct.

Senator BOXER. OK. And that is the case with all of these rules.

I also want to show you what has happened in California, Administrator McCarthy. I think you know this, but I want to show you what happened in the clean air with the dirty air days. In our State, in Southern California, colleagues, we used to have days where there were health advisories and people could not go out; and every time I hear Senator Inhofe and others complain about these rules and say this is baloney, there were no benefits, excuse me. Open your eyes. Look at what happened in L.A. and Southern California. In 1976 we had 166 advisories. People were warned not to go out. Everyone says they care here about the elderly, and we all do. This was huge for the elderly population, to be able to go out and breathe the air. And now, in 2010, guess what? We had zero health advisories.

So I would say, Administrator McCarthy, are you aware of this in Southern California, and are there other places where you can find similar results in the country?

Ms. MCCARTHY. Yes.

Senator BOXER. OK. I also wanted to share something else with you, which is, again, a poll, the poll numbers on all of this. And this is about climate change, where my colleagues are railing against it; and that is a fact, they are. We had an all-nighter that was organized by Senators Whitehouse and Schatz, and we did hear from Senator Inhofe, for which I was very grateful he came down; and he railed against what we were doing and said, in other words, it is a hoax and all the rest, and we respect him and his view.

But no one came down here. This is where people are. People are not with the Republicans on this. Let's just be clear. I am sorry to have to say this in partisan terms, because I served with the great John Chafee. I served with the great John Warner, and I saw bipartisan support to move; and I see none of it now. It is sad. It is sad. And the reasons I don't even want to go into, because I think I know why. But the bottom line is 81 percent of Americans think climate change will be a serious problem if nothing is done to reduce it.

So thank you for doing what you do despite all the pressure, despite all the insults.

Seventy-five percent of Americans say the U.S. should take action on climate change even if other nations do less, because they are smart. We don't wait for China to decide how to treat our people and our economy and human rights and religious freedom. We are America, we lead. So the American people get it.

And I guess I don't have a lot of questions for you, because you are going to get plenty. I just want to say keep going. Keep doing what you are doing based on science.

And I would ask Senator Vitter now.

Senator VITTER. Thank you, Madam Chair and thank you, Madam Administrator. I am going to use my very limited time to ask some questions about the John Beale case, because I do think this case reflects a deeply broken bureaucracy long-term; that it is not an isolated incident and that John Beale, with his good friend Robert Brenner, were instrumental in developing key EPA regulations.

So, Madam Administrator, isn't it true that you received a memo on January 12th, 2011, informing you that Beale's salary was illegal, it exceeded the statutory cap, and recommending that that bonus be terminated?

Ms. MCCARTHY. It is true that I became aware of the bonus, yes.

Senator VITTER. And isn't it true that you did not cancel that illegal bonus until over 2 years later, February 2013?

Ms. MCCARTHY. Actually, Senator, what is true is I did pursue that issue effectively, and I think the Agency was addressing it effectively.

Senator VITTER. But the illegal bonus, you knew it was illegal January 12th, 2011, was canceled February 2013.

Ms. MCCARTHY. Yes. I went ahead and I reported that—

Senator VITTER. So that 2-year rapid response you consider effective?

Ms. MCCARTHY. No. Actually, it took a while to get to the bottom of the John Beale issue because he was a criminal that had systematically intended to fraud the Agency. But the good news is that he is in Federal prison right now, having paid back—

Senator VITTER. But you knew the bonus was illegal and it went on for 2 years.

Ms. MCCARTHY. Actually, I understood that it was being investigated, and I had sent it to the correct people to investigate it.

Senator VITTER. OK. Why, in early 2011, were you reluctant to finalize, to not cancel the bonus? Why were you reluctant to take action?

Ms. MCCARTHY. Actually, I understood that the issue was going to be referred to the Office of the Inspector General. When that happens, you need to give them the opportunity to investigate it and see if it is going to be managed criminally. And I would never want to interfere with an investigation of the Office of the Inspector General.

Senator VITTER. Now, Susan Smith, at OARM, has stated, "Gina is reluctant to finalize cancellation of the bonus unless OARM gives her the OK that the White House is aware and there will not be any political fallout." Was that correct?

Ms. MCCARTHY. I don't know what you are reading, sir, but I don't think I have had a conversation—

Senator VITTER. That was an e-mail from Susan Smith. That was a direct quote from her.

Ms. MCCARTHY. I have never had a conversation with her, so I don't want to speak to her e-mails.

Senator VITTER. Were you concerned to act until the White House looked into it and made sure there would not be any political fallout?

Ms. MCCARTHY. I had no interaction with the White House on this issue whatsoever, to the best of my recollection.

Senator VITTER. That wasn't the question. Were you concerned that the White House look at this regarding political fallout?

Ms. MCCARTHY. That was never a concern of mine, Senator, no.

Senator VITTER. Did you ever talk to Scott Monroe about that?

Ms. MCCARTHY. Many times.

Senator VITTER. OK.

Ms. MCCARTHY. No, I am sorry, not about the White House. I spoke to him about Mr. Beale and his bonus.

Senator VITTER. Well, the same Susan Smith e-mail says that Scott Monroe told her that you had those concerns. Is that just not true?

Ms. MCCARTHY. I never had concerns about the White House's interference or knowledge that—

Senator VITTER. So if Scott Monroe said that, he is not speaking correctly?

Ms. MCCARTHY. Not based on any conversation he had with me, no.

Senator VITTER. OK. Fundamentally, why did it take 2 years to cancel this bonus that was just flat out illegal? The number is above the cap. Why did it take 2 years to cancel that?

Ms. MCCARTHY. Senator, I referred this to the appropriate authorities and we did get to the bottom of it, and we did it. And while it might have taken longer than any of us would have liked, he didn't go into the sunshine of retirement.

Senator VITTER. Well, he did, actually. He was allowed to retire. He did go out in the sunshine of retirement.

Ms. MCCARTHY. Actually, I don't know how much sunshine he is seeing right now, Senator.

Senator VITTER. He was allowed to retire, right?

Ms. MCCARTHY. He was allowed to go to Federal prison.

Senator VITTER. First he was allowed to retire, having gotten \$90,000 of bonus illegally after you knew it was above the cap.

Ms. MCCARTHY. Senator, every employee has their right to retirement, and I am sure he exercised that right.

Senator VITTER. Now, Madam Administrator, you told OIG that you relied on Craig Hooks for advice and that you were advised by Craig Hooks to stand down on the matter, since it was a criminal matter. Is that accurate?

Ms. MCCARTHY. That was my recollection, yes.

Senator VITTER. OK. Are you aware that on Monday Craig Hooks told Chairman Issa's staff that he absolutely never told you to stand down? Are you aware of that?

Ms. MCCARTHY. I am not aware of that, no.

Senator VITTER. OK. You stand by your previous statement that he told you to stand down because it was a criminal matter?

Senator BOXER. I am sorry, we have to move on.

Senator VITTER. Can she answer that final question?

Do you stand by that previous statement of yours?

Ms. MCCARTHY. Yes, sure.

Senator BOXER. Senator Whitehouse.

Senator WHITEHOUSE. Thank you very much.

It looks like we are going to hear a lot more about a convicted former EPA employee than we are going to hear about EPA's budget in this hearing, so let me ask you. You have had long experience with EPA. Is this Mr. Beale character representative of the employees at EPA in terms of work ethic, integrity, or any other feature? Should the misconduct that he engaged in find attribution by association to the rest of the employees of EPA?

Ms. MCCARTHY. I am so glad you ask that question. He is in no way indicative of employees at EPA. They are hardworking professional, dedicated public servants. I have 16,000 people who in no way represent him or anything having to do with him. In fact, the most devastating part of all this is that any indication that that is the case. I am proud of the people that work at that Agency and I am extraordinarily honored to be in the position I am in with them.

Senator WHITEHOUSE. Let me say for the record that I know EPA employees and I have known EPA employees over the years, and the effort to tar all EPA employees with the misconduct of one criminal I think is reprehensible.

Let me further ask you, let's go to the merits of all this, of the EPA's work. Where are you guys on methane leakage? If methane is burned, it is a dramatic improvement over burning coal from a point of view of polluting our environment and oceans with excess carbon dioxide. But if it is not burned, if it just leaks, it is actually worse than carbon dioxide. So getting after the leaks and making sure that it is not leaking is important, because with that natural gas industry can't make its argument that it is actually an improved fossil fuel; it actually loses the battle and suddenly becomes just as bad, perhaps even worse than coal. So that question of methane leakage becomes really vital to the reputation of this industry and to our success at battling climate change. Can you let us know where you are on that? And we have about two and a half minutes.

Ms. MCCARTHY. Sure, Senator. It is a big issue and one that we have begun to tackle. You know that EPA has already issued rules that are driving the recapture of methane and natural gas wells. We are also working with the larger Administration to look at all of the challenges that the Administration sees and potential solutions for reducing methane across a number of industry sectors. The President's Climate Action Plan indicated that the Administration would be putting out a methane strategy. You will be seeing that shortly.

Senator WHITEHOUSE. Very well. I appreciate it, and I will yield back my time.

Senator BOXER. Thank you so much, Senator.

Senator Inhofe.

Senator INHOFE. Thank you, Madam Chairman. I want to ask three questions real quick, and we will talk fast here.

Ms. McCarthy, on January 10th of 2014, you sent a letter to Frances Beinecke, the President of the Natural Resources Defense Council, in which you detailed several regulatory initiatives EPA is undertaking related to shale gas development. In this letter you

state that EPA is continuing to work on its national research study on the potential, potential impacts of hydraulic fracturing or drinking water sources. As you know, we can call as many things up as potential impacts as we want.

Would you commit to me that, to the extent the study evaluates potential impacts, that EPA will work with industry to determine the probability of these potential actions occurring and feature those together with the potential impacts of the report? This is very similar to what you and I actually did successfully not too long ago.

Ms. MCCARTHY. Yes.

Senator INHOFE. You will do that?

Ms. MCCARTHY. Senator, I always have and I will make that commitment to work with industry on these.

Senator INHOFE. Very good. I appreciate it.

In the same letter you state the EPA is working closely with the BLM in supporting their efforts on onshore oil and gas order, which is the proposed guidelines for venting and flaring natural gas. Can you provide the committee with any data or summaries? The procedure there is that the EPA sent the BLM the data. My concern is I would like to have industry, and we could talk about how to set this up, evaluate that data that would be going out. Would you be willing to do that?

Ms. MCCARTHY. Well, I am quite sure that BLM is doing their outreach to industry. We are just providing comment to BLM.

Senator INHOFE. Yes, but you have data that you are giving. I would like to see the data and have an evaluation of that data. In fact, I could do that myself.

Ms. MCCARTHY. It would be data that is already readily available that we would be provided.

Senator INHOFE. That is fair enough. Fair enough.

Ms. MCCARTHY. And it is data that we are trying to make better every day.

Senator INHOFE. Ms. McCarthy, the reason I am introducing, and I think we did it yesterday, or maybe it was today, the 321 legislation is because I know that the EPA isn't looking at the cascading impacts of the rules to determine the costs that it will have on the economy. You look every way for the benefits, but not for the costs, and I want to ask you do you think that the regulations have a cost on the economy beyond the regulated entity. Now, you know what I am talking about here.

Ms. MCCARTHY. Yes, I do.

Senator INHOFE. You can confine it to the regulated entity, but looking down the road at what it is going to be costing all these people. You agree with that?

Ms. MCCARTHY. Senator, we do the best we can to evaluate all costs and benefits. You will be happy to know that Senator Vitter, this is an issue that he raised with us, this whole economy modeling, and we are pursuing that with a new science advisory board panel.

Senator INHOFE. OK. Well, CASAC is going to be meeting in Chapel Hill, North Carolina, to debate the EPA's latest policy assessments. This will be on the ozone standard.

Ms. MCCARTHY. Yes.

Senator INHOFE. It is my understanding that EPA staff has recommended they review a standard as low as 60 parts per billion. I can remember during the Bush administration it was 80 parts, and then we actually went down to some 60 parts. Behind me you will see a map on what would happen if the United States standard were lowered to that level. We are talking about 60 parts per billion. Nearly every county would be out of attainment, certainly all the counties in my State of Oklahoma; and, if you will notice down here, even the Grand Canyon area. If this happened, businesses would not be able to expand, it would essentially close the whole Nation for business and result in millions of job losses.

Do you think lowering the NEC standard would impose costs on the economy that are just not acceptable?

Ms. MCCARTHY. Senator, we are in the middle of the science process. I would rather not speak about any outcome of the ozone standard.

Senator INHOFE. But I will give you a hypothetical. We all deal in those nowadays. If it should come to 60, I don't think you can refute the accuracy of these charts. Would you find that to be unacceptable, economically?

Ms. MCCARTHY. Senator, I think, as you know, the NEC standard is established based on the science, not on costs. We look at costs on the implementation.

Senator INHOFE. And this is the problem. Do you think that is wise? I mean, I have lived with this now for several years, and they said, no, we can't talk about the costs of these things. Why not? You know, people out there are hurting. The Senator from New Jersey was talking about something before. I disagreed with him because I think all these standards and these new regulations are going to cost the poor more than the more affluent people because they spend a higher percentage of their income on heating their homes and this type of thing.

Do you think it is right that we do that? Maybe that ought to be looked at and ought to be changed.

Ms. MCCARTHY. I think it is absolutely right that a science question that asks what is healthy air for all Americans should be answered by the science.

Senator INHOFE. And it should, but we are talking about how to the exclusion of looking at it in terms of the cost to the public.

Senator BOXER. It has started and we are going to move on. The vote has started; we have to move on.

Senator Booker, please keep it to your 5 minutes.

Senator BOOKER. I certainly will.

Just real quickly, because I am new to the U.S. Senate and my colleagues were talking about my possibly mistaking the impact of CO₂ in the air being good for forests and stuff like that. But please help me understand, as just a new guy on this committee. CO₂ in the air causes warming, correct?

Ms. MCCARTHY. That is correct.

Senator BOOKER. Right. So if you have a preponderance of CO₂ in the air and a preponderance of warming, it has effects on our climate, correct?

Ms. MCCARTHY. It does.

Senator BOOKER. And so if you have effects on the climate, it affects everything from the health of our oceans, from coral reefs to the fishing patterns that, frankly, affect the industries of a State like mine in New Jersey, correct?

Ms. MCCARTHY. That is correct.

Senator BOOKER. And, in fact, when you were talking about issues of respiratory health, when the air gets warmer, I have seen it. Again, I am just a guy who is new on this committee, but I have a lot of experience in public schools. And when temperatures warm, you have a lot more cases respiratory problems, including things like asthma, right?

Ms. MCCARTHY. The scientists would agree with you.

Senator BOOKER. Right. So there is a direct correlation to too much CO₂ and respiratory problems and disruptions of fisheries and disruptions of economies and sea levels rising.

Ms. MCCARTHY. That is correct.

Senator BOOKER. Thank you.

The other thing I would like to ask is when EPA issues proposed carbon pollution standards for existing power plants later this year, do you contemplate that States that are not participating in REGIs, regional greenhouse gas initiatives, will be able to use that program to meet their new obligations?

Ms. MCCARTHY. We think that regional approaches could be quite preferable, and we are going to make sure that the standard is flexible enough for States to consider those choices.

Senator BOOKER. I think, actually, the REGIs are phenomenal things, and I guess my point and question is if New Jersey fails to rejoin the REGI, the regional work on this, what types of actions will New Jersey likely need to take in order to comply with the new regulations?

Ms. MCCARTHY. Well, we haven't put out the new regulations, but they will have to look at other opportunities for greenhouse gas reductions that are as cost-effective as they can be. Having participated in the REGI process, it is a pretty cost-effective program to achieve significant reductions.

Senator BOOKER. Right. So, in other words, it is an easy way for New Jersey to meet these new regulations by being a part of our surrounding States; and we have a lot more burden if we are not part of that and a lot more level to hit in order to comply.

Ms. MCCARTHY. Based on the information that I have, it certainly would be a good choice.

Senator BOOKER. Then, last, I know that you and the EPA have a tremendous amount on your plate right now, but 30 years is simply too long to wait. Can I have your commitment that finalizing and releasing for public comment the pending FFS and proposed remedy for the lower eight miles of the Passaic River will be a priority? Because the Passaic River, as you know, is another thing my colleague, who is rightfully concerned about poor and disadvantaged people, in a city, when you see what happens when we allow pollutants to enter rivers like that, poor people suffer because now folks who, 100 years ago, when they couldn't get food, they would go to the river and fish and enjoy the fruit and the bounty of the rivers. That has been taken away by corporations that polluted our

rivers, so this is a big priority for our whole region running through the Passaic River.

Ms. MCCARTHY. As it should be, Senator, and you should rest assured that I have already had two briefings because of my great regional administrator, Judith Enck, who, if I don't put it out soon, she will drive me crazy; and that is official. And I look forward to talking to you about it, and we will get that done.

Senator BOOKER. I appreciate that. And you should give her a raise, but obviously keep it under the cap, or you will be back here talking about it.

Ms. MCCARTHY. I can't make that my commitment.

Senator BOOKER. OK.

Senator BOXER. Is that it for you, Senator?

Senator BOOKER. That is it for me.

Senator BOXER. Well, thank you.

Senator BOOKER. I yield the rest of my time.

Senator BOXER. For the people who just joined us, we are going to have to end this when there are 4 minutes left to vote, so I think we can hear from two of our Senators.

Senator WICKER.

Senator WICKER. Madam Chair, I would be happy to preside over this hearing, if you would like to go.

Senator BOXER. Thank you for the offer. I will take it under advisement.

Senator WICKER. Thank you so much.

Senator BOXER. Don't you want to vote?

Senator WICKER. I am going to vote when the Chair votes.

Senator BOXER. OK.

Senator WICKER. Somehow I believe the president of the Senate is going to wait for Senator Boxer to vote.

Administrator McCarthy, Senator Booker is from Newark, New Jersey. Sometimes it is 10 degrees in Newark, sometimes it is 85 or 90 degrees. A wide range of temperatures in Newark. Is it your testimony, let's say temperatures have risen by 1.5 degrees. Let's just stipulate that the average temperature in Newark, New Jersey has risen by 1.5 degrees over the last two decades because of climate change. Are you telling me that there is scientific evidence that that fact causes more lung disease among children?

Ms. MCCARTHY. Well, Senator, to really properly look at climate change, we look generally at three decades or longer.

Senator WICKER. OK, three decades.

Ms. MCCARTHY. The information that we know is that climate change is happening. One of the lines of evidence of that is increased temperature; it is rising—

Senator WICKER. Well, no. In the brief—

Ms. MCCARTHY [continuing]. Ozone.

Senator WICKER. In the brief time you have to answer the question, my question is the Senator's line of questioning is that increases in the average temperature cause more lung disease among children. Is that supported by the science?

Ms. MCCARTHY. What the science tells us is when the temperature gets warmer it increases a level of ozone, and that ozone pollution actually has an impact on respiratory health, as well as cardiac health.

Senator WICKER. OK, well, I would be interested in your supplying to the committee any scientific basis for the statement that increased average temperatures actually increase respiratory disease among children.

Ms. MCCARTHY. OK. I am happy to do that.

Senator WICKER. If you would supply that.

Ms. MCCARTHY. You can actually find it on our Web page and the climate change page.

Senator WICKER. OK, fine. If you will get that to me, that is great.

Let me just ask you briefly, then, Madam Administrator, if I can talk about air grant money.

Ms. MCCARTHY. Yes.

Senator WICKER. And, again, this is something we ought to be able to agree on. Maybe you ought to go where the problem is. There is a decades-old EPA allocation formula that gives the Southeast region 12 percent, when actually we have 20 percent of the Nation's population. How can EPA continue to develop strengthening rules and standards while at the same time limiting access to resources for the States to get their fair share?

Ms. MCCARTHY. Well, Senator, we have actually been proposing to change that formula and to allocate resources differently given the changes that have happened over the past decade on population. We certainly feel that there is a need for change. We are looking to do that over a period of time. Congress has actually provided language in our budget that does not allow us to do that last year. We will see what happens in fiscal year 2015.

Senator WICKER. OK. Was this a rider to an appropriation bill or was this a statute?

Ms. MCCARTHY. It is a congressional report act language that has prohibited EPA from implementing the revised allocation methodology. They have done that since fiscal year 2011, when we first proposed it.

Senator WICKER. OK. Finally, I would like to work with you on that problem, Madam Administrator. Let's talk about helping local governments implement the upgrades required to wastewater treatment facilities and more stringent water regulations. A significant and basic problem has been that many of these towns don't have the tax base. And you and I have talked about this. They don't have the tax base to meet the cost of upgrading their wastewater systems.

However, not acting results in harsh fines imposed by the EPA. In your nomination hearing I asked several questions regarding the Clean Water and Drinking Water State Revolving Funds, and you said you would work with me on that. I am just concerned that we don't have a proposal going forward and, as a matter of fact, we are now seeing a proposal from EPA and from the Administration to cut this by \$581 million to the State revolving funds.

Senator BOXER. I am sorry. We have to move on if we are going to hear from your two colleagues, so we will go next to Senator Fischer for 4 minutes and then Senator Boozman.

Senator WICKER. Does the witness get to answer the question?

Senator BOXER. She does not at this point; she can do it for the record.

Senator WICKER. Could you supply that answer on the record, please?

Ms. MCCARTHY. Certainly.

Senator BOXER. We have votes. We have 5 minutes left to vote. Four minutes, please.

Senator FISCHER. Thank you, Madam Chair.

Thank you, Administrator. It is nice to see you again.

Ms. MCCARTHY. Nice to see you, too.

Senator FISCHER. Thank you for being here. I am sorry that we are all rushing here at the end now. I can tell you that I have some concerns maybe that we are seeing our coal-fired electric plants in Nebraska, our utilities, they are spending a lot of time, they are spending a lot of resources on keeping their units in compliance with regulations; and I don't think they are then able to spend that time in resources on the innovations that could possibly lessen our dependence on coal.

We have an example here for you regarding regional haze. We have a Nebraska utility, which is LES, the city of Lincoln. It owns a little more than 10 percent of the coal-fired power plant in Wyoming, the Laramie River Station. The Wyoming Department of Environmental Quality proposed a plan to address regional haze that would require technology costing approximately \$100 million, and so the Nebraska utility share sent about \$10 million. The EPA rejected the Wyoming DEQ plan and substituted its own plan that requires technology at a cost of \$800 million, which then is about \$80 million for the city of Lincoln, the LES utility that would have to provide that.

There would be a very small improvement in visibility. But this difference is going to deprive this Nebraska utility of moving forward on their investments in wind, which they have, and in solar, in energy efficiency. You know, we are talking a fairly small city, the city of Lincoln. It is large for Nebraska; small nationally.

That is just one example. So I believe that that is replicated across the country, though. You know, LES is a leader in looking at renewables. The citizens and the city of Lincoln want to move forward in that direction, but polls have shown they are not willing to pay for it, and I think that is also replicated across the country, the costs that are incurred sometimes, especially when they have to meet requirements from the EPA.

What are your feelings on that? Do you see that policy moving forward with EPA? Are you going to try and reach out more to help utilities be responsible in their coal-fired plants, but also to move forward?

Ms. MCCARTHY. Senator, we are doing the best we cannot just to reach out to the utilities to understand what their business plans are moving forward and how we can keep the lights on and keep it reliable, but we are also working very closely with the States on these regional haze issues. We understand that they are important environmental benefits, but they have to be looked at in the context of how much they cost and what they do in terms of moving the clean energy system forward. So if we need to work more closely together, we are more than willing to do that.

Senator FISCHER. OK, thank you. You know, we hear about the war on coal and you hear about that as well.

Ms. MCCARTHY. Yes.

Senator FISCHER. Is there a war on coal? You know, a lot of people in Nebraska think there is because we have those coal-fired plants. Do you think it is fair to say maybe the EPA has somewhat of a war on coal so that we can lessen our dependence upon coal in this country?

Ms. MCCARTHY. Senator, I don't think that that is fair to say. What we are trying to do is our job to protect public health by reducing pollution from some of the largest sources of that pollution.

Senator FISCHER. And I have a few seconds left. I am very concerned about the water rules that are coming out from EPA. Water is a State resource in Nebraska. I believe we manage it in a very responsible way. I hope that you will have a long period there. Would you commit to a long period for comments, 180 days?

Senator BOXER. We will have to do that answer for the record. Senator FISCHER. Thank you, Madam Chair.

[The prepared statement of Senator Fischer follows:]

STATEMENT OF HON. DEB FISCHER,
U.S. SENATOR FROM THE STATE OF NEBRASKA

Chairman Boxer and Ranking Member Vitter, thank you for holding this hearing today to review EPA's budget. I want to welcome Administrator McCarthy. Thank you for being here.

Budget hearings are a fundamental responsibility of this committee. It is important for Congress to continue its oversight of the programs it has authorized and examine whether taxpayers' money is being used appropriately, effectively, and efficiently to fulfill EPA's core mission to protect human health and the environment.

A clean and healthy environment is important to us all. Over the past several decades, we have made great strides in improving our air and water quality and protecting our natural resources—while growing our economy. In Nebraska, farmers and ranchers are growing more food and fiber in an increasingly responsible and sustainable manner. Our public power utilities are serving more customers while reducing emissions. Businesses are achieving innovations to provide better goods and services to enhance quality of life, as they maximize efficiencies and reduce their environmental footprint.

We must work together to pursue a path forward that continues both these environmental and economic achievements, one that encourages meaningful environmental improvements without stifling economic growth.

As the EPA proposes a budget that shifts significant resources in support of the President's Climate Action Plan and aimed at reducing greenhouse gas emissions, we must continue to scrutinize the costs and benefits of proposed actions.

Because these issues are global in nature, we must examine what benefit we are seeking by limiting American utilities' choice of power-generation technologies that we know will drive up electricity costs and customers' monthly bills and jeopardize energy reliability.

While EPA routinely claims regulatory benefits in excess of the costs, the benefit estimates are speculative at best. We simply must have more transparency and accountability when it comes to the underlying scientific justifications for these rules.

EPA is seeking to expand its regulatory control in many new ways—including an alarming Federal takeover of water—all at a time when EPA's out-of-control "playbook" is being unveiled. The deceitful schemes of John Beale and his leadership in the creation of costly air regulations should give us all pause and even greater reason to carefully examine the process, science, and priorities of the agency.

Today's hearing is an important step in providing this needed oversight. We must work to ensure EPA is operating transparently and pursuing a positive course for our environment and our economy.

Thank you, Madam Chairman.

Senator BOXER. Also, Senator Boozman, we will put your questions and get those into the record as well.

Senator BOOZMAN. Yes, ma'am. Thank you.

Senator BOXER. Thank you.

And with the last 4 minutes, Senator Barrasso.

Senator BARRASSO. Thank you, Madam Chairman. I ask unanimous consent my entire statement be put in the record.

Senator BOXER. Without objection. Absolutely.

Senator BARRASSO. Thank you.

Senator BARRASSO. Ms. McCarthy, I would just highlight the Casper Star Tribune last week, Andy v. EPA, a gentleman in Uinta County. Uinta County resident faces \$75,000 in daily fines for his pond.

So I want to ask about the EPA's specific Web site for the new proposed waters of the U.S. rule.

Ms. MCCARTHY. Yes.

Senator BARRASSO. The EPA has a section entitled Fact Sheet: How the Proposed Waters of the U.S. Rules Benefits Agriculture. The site states that, under the proposed rule, the Army Corps will exempt 53 farming practices as established by the Natural Resource Conservation Services, which means that any farmer or rancher who used those 53 practices in a newly expanded, federally covered water would be exempt. This list, however, of 53 does not cover all existing agriculture practices. There are a number of farming and ranching practices that aren't covered on the list that occur every day without penalty. Under the new proposed rule will those farmers and ranchers need to get a permit or find that they are penalized if they continue to use those non-covered 53 practices and newly federally covered waters under this proposed new rule?

Ms. MCCARTHY. Actually, Senator, it is not taking away any of the agriculture exemptions. What it is trying to do is provide clarity so you don't have to go and ask. That is what this rule does. It actually worked with the agriculture community to identify those practices that we could highlight. It even set up a really good process to expand on that. But it didn't take away a single agriculture exemption that currently exists.

Senator BARRASSO. So what about the farmers and ranchers who use these 53 new covered practices, but the farmers and ranchers don't specifically follow the Natural Resource Conservation Services Federal definition of these farming practices, you know, perfectly to a tee, in the newly expanded Federal waters? Would they need to get new Clean Water Act permit or be penalized?

Ms. MCCARTHY. Nobody needs to get a permit today or under this rule, should it go forward as proposed, that didn't need it today.

Senator BARRASSO. We heard the previous Senator ask a question specifically about would you expand to 180 days the comment period and her time ran out. Would you like to comment on that or respond to that?

Ms. MCCARTHY. Actually, I can certainly respond to the Senator. I don't believe that that is what we are currently proposing, but, as always, if people comment and want to request it, we will respond to that.

Senator BARRASSO. Well, I would request it as well, as another Senator.

And, Senator Boozman, I am on the last minute and a half if you have a specific question that you would like to ask. Go right ahead, please.

[The prepared statement of Senator Barrasso follows:]

STATEMENT OF HON. JOHN BARRASSO,
U.S. SENATOR FROM THE STATE OF WYOMING

Ms. McCarthy, I am from what I consider to be the most beautiful State in the country. Folks in my State believe we can balance our energy needs with our environmental needs. People in my State watch what you and the EPA are doing, and they think this agency is extreme.

Here are some of the examples of what we are seeing. We have seen that when the EPA cannot get their way in Congress, they go around Congress, and try to issue regulations or guidance to accomplish policies that the American people soundly rejected.

The American people rejected cap and trade, and the EPA produced climate change regulations instead.

The American people rejected legislation to remove the word navigable from the definition of waters of the United States, and the EPA proposed guidance to do it anyway.

We learned about e-mails that were sent for years under a false identity to circumvent recordkeeping laws so the EPA could keep the public in the dark. If the business of the EPA is transparent, and in the best interest of the American people, why does the EPA leadership circumvent the law using a false identity?

We learned of the "crucify them" mentality, where small business owners and ranchers are bullied into submission by arrogant and unaccountable bureaucrats. Former EPA Region 6 Administrator Al Armendariz had to resign after comparing EPA's approach to enforcement as similar to a Roman crucifixion.

This "crucify them" approach has been most recently on display in the treatment by the EPA of my constituent, Mr. Andrew Johnson. He is facing thousands of dollars in penalties from the EPA for constructing a stock reservoir on the Six Mile Creek.

According to a March 18th Ron Arnold column in the Washington Examiner, "EPA regional bureaucrat Andrew M. Graydosh issued a compliance order requiring Johnson to return the creek to its original condition in 60 days. Graydosh threatened Johnson with fines of \$75,000 per day per violation—which could reach \$187,500 per day, or over \$5.5 million in a month—if he didn't comply. Johnson had 10 days to reply."

The Casper Star Tribune stated on March 19th that such a penalty was "a penalty often reserved for companies that emit toxic hazards."

This treatment by EPA is draconian and unacceptable.

Most recently, Ranking Member Vitter has done a thorough job in highlighting the activities of one John Beale. Beale was the senior lieutenant to the current EPA Administrator when she was in charge of the Air and Radiation Office, and he was also the highest paid on staff. Beale not only masqueraded for years as a pretend CIA agent, but also as a pretend environmental rulemaker.

As the Washington Times summed up in a March 19th article entitled "Fake CIA agent helped craft sweeping environmental rules while at EPA," the article described Beale as "a former high-ranking EPA staffer convicted of stealing nearly \$900,000 by pretending to be a CIA spy, had virtually no experience, got his job with help from a college buddy, and went on to play a key role in sweeping environmental regulations." They also note, as does Senator Vitter's report, that "Those regulations remain in place despite John C. Beale's lack of environmental expertise."

We now know that EPA has allowed this fraud's work to stand. In fact, the underlying data, the basis for numerous job crushing EPA rules has not been shared with Congress, or with the public, despite repeated requests. This is despite the sweeping impact of these rules on the economy. The EPA's response to Congress and the public is always to say "just trust us." I would put as much trust in this EPA as I would in Beale being a real spy. It defies logic that his work will be allowed to stand, or why data underlying EPA's long list of job crushing rules cannot be released.

It is clear that the EPA is broken. What we should be discussing is what are the best ways to manage our air and water while trying to get our economy moving again. The only way to do that is to have an agency that can work with us to chart a bipartisan path of consensus, sound science, transparency and accountability. Today it is clear we do not have such an agency.

I thank the Chair and look forward to the testimony.

Senator BOOZMAN. The only thing that I would like to do, Madam Chair, is I ask unanimous consent to insert into the record a letter to the Administrator that is signed by every minority member, re-

questing that the Agency provide all documents relating to EPA's proposal to cut funding for the Clean Water and Drinking State Revolving Funds.

Senator BOXER. Sure. Without objection.
[The referenced document follows:]

BARBARA BOXER, CALIFORNIA, CHAIRMAN
 MAX BAILEY, MONTANA
 THOMAS R. CARPER, DELAWARE
 BENJAMIN L. CARDIN, MARYLAND
 BERNARD SANDERS, VERMONT
 STELEEN WYNTON-GUNDE, BRIGGS ISLAND
 TOM USALL, NEW MEXICO
 JEFF MERKLEY, OREGON
 KRISTEN SILVERMAN, NEW YORK
 CORY A. BOOKER, NEW JERSEY
 DAVID VITTER, LOUISIANA
 JAMES M. INHOFE, OKLAHOMA
 JOHN BARRASSO, WYOMING
 JEFF BENNING, ALABAMA
 MIKE CRAPO, IDAHO
 ROGER WICKER, MISSISSIPPI
 JOHN BOGDMAN, MONTANA
 SUE FISHER, NEBRASKA

United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

WASHINGTON, DC 20510-6175

REBEKAH FORTNER, MAJORITY STAFF DIRECTOR
 ZAK PAUL, REPUBLICAN STAFF DIRECTOR

March 25, 2014

The Honorable Gina McCarthy
 Administrator
 U.S. Environmental Protection Agency
 1200 Pennsylvania Ave, NW
 Washington, DC 20460

Dear Ms. McCarthy,

As you are aware, the President's Fiscal Year (FY) 2015 Budget requested \$7.9 billion in funding for the Environmental Protection Agency (EPA).¹ In turn, the Agency has professed that this is an exercise in fiscal restraint, slashing their budget by 4%, or \$309.9 million from FY 2014 enacted levels.² However, EPA achieves these alleged savings by slashing funds, \$581 million, from the Clean Water and Safe Drinking Water State Revolving Fund (SRF), a popular and effective program that loans funds to states so that they may invest in water and sanitation infrastructure.³

As EPA is aware, SRF programs are important to the continued investment in local clean water initiatives, and to insuring safe and clean water for all Americans. Moreover, they help offset the high cost of unfunded mandates. EPA has never provided an adequate rationale for why the President proposes slashing SRF funds, and yet EPA appears to endorse cutting the program by 24%, shifting the savings to other agency priorities. Such cuts to the SRF have been rejected by both Republicans and Democrats alike. The broad bipartisan support for the SRF suggests that Congress will continue to support the program. Accordingly, we are concerned that EPA's proposal is wholly illusory or otherwise disingenuous, as the Agency has yet to provide reasoning to Congress that would justify endorsement of the proposal.

This is not the first time EPA has proposed large cuts to this program. In FY 2013, EPA proposed a 15% cut of \$782.4 from FY 2012 enacted levels.⁴ In response, Congress overruled EPA's recommendation and appropriated \$2.807 billion for the SRF program, which restored and actually increased funding for this program.⁵ In FY 2014, EPA again proposed to slash this program by \$895.4 million from FY 2013 enacted.⁶ Once again Congress did not agree with

¹ OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT BUDGET OF THE UNITED STATES GOV'T, FISCAL YEAR 2015 133 (2014).

² Briefing Presentation for Staff of S. Comm. on Env't & Pub. Works on FY 2015 President's Budget 3 (Mar. 5, 2014); Press Release, Env'tl. Prot. Agency, EPA's FY 2015 Budget Proposal Focuses on Delivering Core Env'tl. and Health Protections 1 (Mar. 4, 2014) (on file with Committee).

³ ENVTL. PROT. AGENCY, EPA-190-S-14-001, FISCAL YEAR 2015 BUDGET IN BRIEF 24 (Mar. 2014).

⁴ ENVTL. PROT. AGENCY, EPA-190-S-11-001, FISCAL YEAR 2013 BUDGET IN BRIEF 15 (Feb. 2012).

⁵ Consolidated And Further Continuing Appropriations Act, 2013, PL. 113-6, 127 Stat 198.

⁶ ENVTL. PROT. AGENCY, EPA-190-S-13-001, FISCAL YEAR 2014 BUDGET IN BRIEF 18 (Apr. 2013).


The Honorable Gina McCarthy
March 25, 2014
Page 2 of 2

EPA and restored the funding EPA proposed to cut.⁷ Given this trend, EPA could expect Congress to restore funding to the SRF program again this year without clear justification. Knowing the nation's debt and deficit challenges we would presume EPA would take seriously any spending proposals on critical programs.

In light of these concerns, we request that EPA provide us with all documents referring or relating to EPA's development of its 2015 budget request for SRF programs. The information and documents provided should include any studies, data, projects, and research conducted, or relied on by EPA in making its determination, as well as correspondence discussing the funding level for SRF programs. Your prompt attention to this matter is greatly appreciated.

If you have any questions regarding this letter, please feel free to have your staff contact Kristina Moore with the Senate Committee on Environment and Public Works at (202) 224-6176.

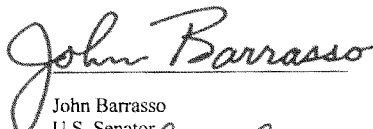
Sincerely,



David Vitter
U.S. Senator



James Inhofe
U.S. Senator



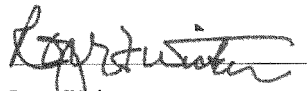
John Barrasso
U.S. Senator



Jeff Sessions
U.S. Senator



Mike Crapo
U.S. Senator



Roger Wicker
U.S. Senator



John Boozman
U.S. Senator



Deb Fischer
U.S. Senator

⁷ Consolidated Appropriations Act, 2014, PL 113-76 title II, 128 Stat 5.

Senator BOOZMAN. Thank you, Madam Chair.

Senator BOXER. Absolutely. I want to thank both Senators for your cooperation.

I am going to put in the record the statement by the Academy of Pediatrics, American Academy: "Heat caused by climate disruption is especially harmful to children." I think, Administrator, if you could send that to Senator Wicker.

Last, I must put in the record, in response to Senator Vitter's attack on you, Administrator McCarthy, on Beale, page 22 and page 26 of the committee's briefing, where the IG said you were the first person and the only senior person to call attention to this rogue employee, and I want to again thank you.

[The referenced documents follow:]

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Global Climate Change and Children's Health

Committee on Environmental Health

Pediatrics 2007;120;1149; originally published online October 29, 2007;

DOI: 10.1542/peds.2007-2645

The online version of this article, along with updated information and services, is located on the World Wide Web at:
<http://pediatrics.aappublications.org/content/120/5/1149.full.html>

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2007 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™





POLICY STATEMENT

Global Climate Change and Children's Health

Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of All Children

Committee on Environmental Health

ABSTRACT

There is broad scientific consensus that Earth's climate is warming rapidly and at an accelerating rate. Human activities, primarily the burning of fossil fuels, are very likely (>90% probability) to be the main cause of this warming. Climate-sensitive changes in ecosystems are already being observed, and fundamental, potentially irreversible, ecological changes may occur in the coming decades. Conservative environmental estimates of the impact of climate changes that are already in process indicate that they will result in numerous health effects to children. The nature and extent of these changes will be greatly affected by actions taken or not taken now at the global level.

Physicians have written on the projected effects of climate change on public health, but little has been written specifically on anticipated effects of climate change on children's health. Children represent a particularly vulnerable group that is likely to suffer disproportionately from both direct and indirect adverse health effects of climate change. Pediatric health care professionals should understand these threats, anticipate their effects on children's health, and participate as children's advocates for strong mitigation and adaptation strategies now. Any solutions that address climate change must be developed within the context of overall sustainability (the use of resources by the current generation to meet current needs while ensuring that future generations will be able to meet their needs). Pediatric health care professionals can be leaders in a move away from a traditional focus on disease prevention to a broad, integrated focus on sustainability as synonymous with health.

This policy statement is supported by a technical report that examines in some depth the nature of the problem of climate change, likely effects on children's health as a result of climate change, and the critical importance of responding promptly and aggressively to reduce activities that are contributing to this change.

BACKGROUND

"Warming of the climate system is unequivocal."¹ According to the National Climatic Data Center, all records indicate that during the past century, global surface temperatures have increased at a rate near 0.6°C per century (1.1°F per century); this trend has been 3 times larger since 1976.² Human activity, particularly the burning of fossil fuels, has very likely (>90% probability) driven this rise by greatly increasing atmospheric concentrations of carbon dioxide (CO₂) and other greenhouse gases (GHGs).¹

There is strong consensus among expert scientists that Earth is undergoing rapid, global climate change,^{1,3} although there remains uncertainty about how rapidly and extensively the climate will change in the future. Overall scientific predictions agree, however, that temperatures and sea level will continue to rise

www.pediatrics.org/cgi/doi/10.1542/peds.2007-2645
doi:10.1542/peds.2007-2645

All policy statements from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

Key Words

climate change, global warming, child, pediatric, health, sustainable development

Abbreviation

GHG—greenhouse gas

PEDIATRICS (ISSN Numbers: Print, 0031-4009; Online, 1098-4275). Copyright © 2007 by the American Academy of Pediatrics

throughout the 21st century.^{1,4} Even if GHG emissions were abruptly reduced to zero, the planet would continue to warm for decades until the energy stored in the system equilibrates.⁵ The possibility of reaching a tipping point at which abrupt, large, and irreversible change could be superimposed on current trends adds both urgency and further ambiguity to the situation.⁶ Current human activities are accelerating these changes, and future human activities will affect their trajectories; the window of opportunity for successful mitigation, therefore, may be very short.⁷ Actions made in the coming decade will have a profound effect on global health and, in particular, on children's health.

DIRECT EFFECTS OF CLIMATE CHANGE ON CHILDREN'S HEALTH

Because of their physical, physiologic, and cognitive immaturity, children are often most vulnerable to adverse health effects from environmental hazards.⁸ As the climate changes, environmental hazards may shift and possibly increase (Fig 1), and children are likely to suffer disproportionately from these changes.⁹ Anticipated direct health consequences of climate change include injury and death from extreme weather events and natural disasters, increases in climate-sensitive infectious diseases, increases in air pollution-related illness, and more heat-related, poten-

tially fatal, illness. Within all of these categories, children have increased vulnerability compared with other groups (see the accompanying technical report¹⁰).

INDIRECT EFFECTS OF CLIMATE CHANGE AND IMPLICATIONS FOR FUTURE GENERATIONS

Additional effects of climate change, with profound implications for the health and welfare of future generations of children, are anticipated. Food availability could be reduced as land and ocean food productivity patterns shift and species diversity declines.¹¹ Water availability will change and become too abundant in some regions (flooding) and much reduced in others (drought).¹² Coastal populations will be forced to move because of the rising sea level. Large-scale, forced migrations are conceivable, driven by abrupt climate change, natural disaster, or political instability over resource availability.¹³

The speed with which global GHG emissions can be reduced will have a significant effect on the rate and degree of warming, but even the most optimistic scenarios describe continued warming into the next century.¹⁵ As climate change progresses, social and political institutions must respond with aggressive mitigation and flexible adaptation strategies to preserve and protect public health, particularly for children.

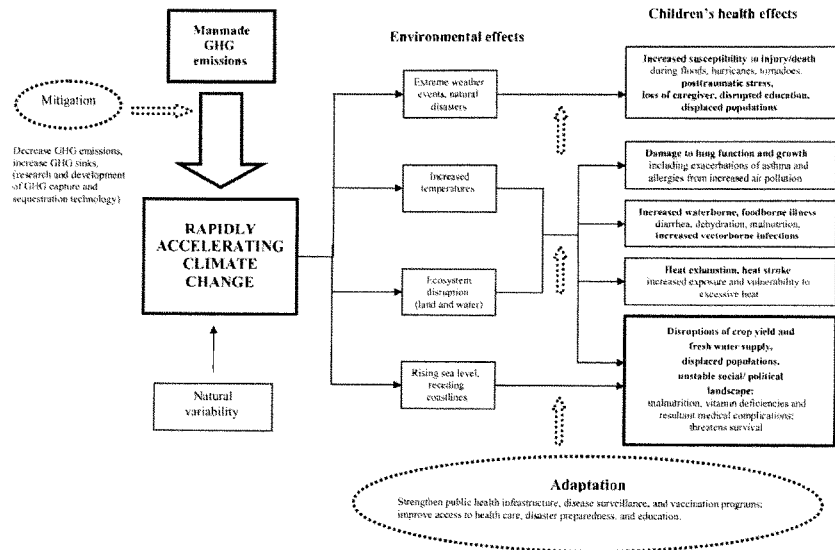


FIGURE 1 Potential effects of global climate change on child health. (Adapted from McMichael et al¹⁴ and Haines and Patz¹⁵.)

MITIGATION AND ADAPTATION STRATEGIES

Strategies to address the effects of climate change (mitigation and adaptation) are concepts that focus on both primary and secondary prevention strategies in pediatric health care (Fig 1). Mitigation (primary prevention) involves reducing GHG concentrations in the atmosphere with the goal of reducing climate change. Adaptation (secondary prevention) involves developing public health strategies to minimize and, in some cases, eliminate local and regional adverse health outcomes that are anticipated from climate change.

A wide variety of governmental and nongovernmental organizations have developed detailed lists of mitigation and adaptation strategies, from international conventions such as the Kyoto Protocol¹⁴ to individual actions such as reducing automobile use.¹⁵

However, any solutions that address climate change must be developed within the context of overall sustainable development (the use of resources by the current generation to meet current needs while ensuring that future generations will be able to meet their needs). Given the health implications of climate change for current and future generations of children, the disease-prevention role for pediatric health care professionals includes advocating for environmental sustainability.

RECOMMENDATIONS TO PEDIATRICIANS

Pediatricians are dedicated to the promotion and protection of children's health. Climate change threatens the health, welfare, and future of current and subsequent generations of children. Pediatricians can incorporate considerations of the effects of climate change on health into their professional practice and personal lives in many ways, including patient education, lifestyle practices, and political advocacy. Some possible approaches might include the following.

1. Recognize and educate yourself about the links between child health and climate change. Existing anticipatory guidance already incorporates many issues that can help mitigate climate change. For example, encouraging families and children to walk or ride bicycles more may reduce automobile emissions.
2. Advocate for comprehensive local and national policies that address climate change to improve the health of children now and in the future. Educate elected officials on the health risks to children from climate change; write letters to the editor, attend public meetings, or provide expert testimony. Work with local schools, child care centers, community organizations, and businesses on projects that will help reduce GHGs. Support policies to expand parks and green spaces, strengthen public transport, improve sidewalks and bicycle lanes, and create local award systems for energy-efficient businesses, buildings, organizations, and households.

3. Serve as a role model for practices that promote environmental sustainability. Emphasize energy conservation in your workplace, encourage and model reduced dependency on automobile travel, and consider the environmental and energy costs when making major purchases for your practice or institution.
4. Help to build and support coalitions across disciplines and institutions to search for novel, comprehensive approaches to mitigate and adapt to climate change in your community and region. Work with local and state health departments to strengthen public health infrastructure, disease surveillance and reporting, and disaster preparedness.
5. Work to ensure that concepts related to the pediatric health implications of climate change are part of pediatric training and curricula.

RECOMMENDATIONS TO GOVERNMENT

Government at all levels, from the smallest municipalities to the national and international levels, should implement aggressive policies to halt man-made contributions to climate change and to mitigate its impact on children's health.

1. Develop aggressive, long-term policies to reduce the major contributing factors to global climate change.
2. Invest in prudent and vital preparations for our public health care systems, including immunization programs and disease surveillance, reporting, and tracking.
3. Give specific attention to the needs of children in emergency management and disaster response.^{13,16}
4. Support education and public awareness of the threats from climate change and their implications for public and children's health now and in the future.
5. Fund interdisciplinary research to develop, implement, and measure outcomes of innovative strategies to both mitigate and adapt to climate change, particularly in areas with direct implications for children's health.

COMMITTEE ON ENVIRONMENTAL HEALTH, 2006–2007

Michael W. Shannon, MD, MPH, Chairperson
 Dana Best, MD, MPH
 Helen J. Binns, MD, MPH
 Joel A. Forman, MD
 Christine L. Johnson, MD
 Catherine J. Karr, MD, PhD
 Janice J. Kim, MD, PhD, MPH
 Lynnette J. Mazur, MD, MPH
 James R. Roberts, MD, MPH

PAST COMMITTEE MEMBER

*Katherine M. Shea, MD, MPH

LIAISONS

Elizabeth Blackburn, RN
 US Environmental Protection Agency

Mark Anderson, MD
Centers for Disease Control and Prevention/National
Center for Environmental Health
Sharon Savage, MD
National Cancer Institute
Walter Rogan, MD
National Institute of Environmental Health Sciences

STAFF

Paul Spire

*Lead author

REFERENCES

1. Intergovernmental Panel on Climate Change. Climate change 2007: the physical science basis—summary for policy makers. Available at: www.ipcc.ch/SPM2Feb07.pdf. Accessed April 18, 2007
2. National Climatic Data Center. Climate of 2005 annual review: temperature trends. Available at: www.ncdc.noaa.gov/oa/climate/research/2005/ann/global.html#Trends. Accessed April 18, 2007
3. US Environmental Protection Agency. Climate change-science: state of knowledge. Available at: www.epa.gov/climatechange/science/stateofknowledge.html. Accessed April 18, 2007
4. Intergovernmental Panel on Climate Change. Climate change 2001: synthesis report—summary for policymakers. Available at: www.ipcc.ch/pub/un/syren/sum.pdf. Accessed April 18, 2007
5. Hansen J, Nazarenko L, Ruedy R, et al. Earth's energy imbalance: confirmation and implications. *Science*. 2005;308:1431–1435
6. Schiermeier Q. A sea change. *Nature*. 2006;439:256–260
7. Hansen J, Sato M, Ruedy R, Lo K, Lea DW, Medina-Elizade M. Global temperature change. *Proc Natl Acad Sci U S A*. 2006;103:14288–14293
8. Eitzel RA, Balk SJ, eds. *Pediatric Environmental Health*. 2nd ed. Elk Grove Village, IL: American Academy of Pediatrics; 2003
9. Shea K. Global environmental change and children's health: understanding the challenges and finding solutions. *J Pediatr*. 2003;143:149–154
10. American Academy of Pediatrics, Committee on Environmental Health. Global climate change and children's health. *Pediatrics*. 2007;120(5). Available at: www.pediatrics.org/cgi/content/full/120/5/e1359
11. Slingo JM, Challinor AJ, Hoskins BJ, Wheeler TR. Introduction: food crops in a changing climate. *Philos Trans R Soc Lond B Biol Sci*. 2005;360:1983–1989
12. United Nations Environment Programme. Potential impacts of climate change: fresh water stress—current population at risk. Available at: www.grida.no/climate/vital/38.htm. Accessed April 18, 2007
13. McMichael A, Githek OA. Human health. In: McCarthy JT, Canziani OF, Leary NA, Dokken DJ, White KS, eds. Climate Change 2001: Impacts, Adaptations, and Vulnerability. Geneva, Switzerland: Intergovernmental Panel on Climate Change; 2001:453–485. Available at: www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARchap9.pdf. Accessed April 18, 2007
14. United Nations Framework Convention on Climate Change. Kyoto Protocol. Available at: http://unfccc.int/kyoto_protocol/items/2830.php. Accessed December 19, 2006
15. Earthday Network. Climate change solutions: what you can do right now. Available at: www.earthday.net/resources/2006materials/Top10.aspx. Accessed December 19, 2006
16. US Department of Health and Human Services, Agency for Healthcare Research and Quality. Pediatric terrorism and disaster preparedness: a resource guide for pediatricians. Available at: www.ahrq.gov/research/pedprep/resource.htm. Accessed April 18, 2007
17. Testimony of Steven Krug, MD, FAAP, on behalf of the American Academy of Pediatrics, before the House Homeland Security Subcommittee on Emergency Preparedness, Science and Technology, July 26, 2006. Available at: www.aap.org/advocacy/washing/ER_readiness.testimony/FINAL.pdf. Accessed April 18, 2007
18. McMichael AJ, Woodruff RE, Hales S. Climate change and human health: present and future risks. *Lancet*. 2006;367:859–869
19. Haines A, Patz JA. Health effects of climate change. *JAMA*. 2004;291:99–103

Global Climate Change and Children's Health

Committee on Environmental Health

Pediatrics 2007;120;1149; originally published online October 29, 2007;

DOI: 10.1542/peds.2007-2645

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/120/5/1149.full.html
References	This article cites 7 articles, 3 of which can be accessed free at: http://pediatrics.aappublications.org/content/120/5/1149.full.html#ref-list-1
Citations	This article has been cited by 10 HighWire-hosted articles: http://pediatrics.aappublications.org/content/120/5/1149.full.html#related-urls
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): Community Pediatrics http://pediatrics.aappublications.org/cgi/collection/community_pediatrics_sub Council on Environmental Health http://pediatrics.aappublications.org/cgi/collection/council_on_environmental_health International Child Health http://pediatrics.aappublications.org/cgi/collection/international_child_health_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://pediatrics.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://pediatrics.aappublications.org/site/misc/reprints.xhtml

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2007 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



Table of Contents

U.S. Senate	Date: Wednesday, September 25, 2013
Committee on Environment and Public Works	Washington, D.C.
STATEMENT OF:	PAGE:
THE HONORABLE BARBARA BOXER, A UNITED STATES SENATOR FROM THE STATE OF CALIFORNIA	2
PATRICK SULLIVAN, ASSISTANT INSPECTOR GENERAL FOR INVESTIGATIONS, U.S. ENVIRONMENTAL PROTECTION AGENCY	6
ARTHUR ELKINS, INSPECTOR GENERAL, U.S. ENVIRONMENTAL PROTECTION AGENCY	14
THE HONORABLE DAVID VITTER, A UNITED STATES SENATOR FROM THE STATE OF LOUISIANA	20

BRIEFING

Monday, September 30, 2013

United States Senate
Committee on Environment and Public Works
Washington, D.C.

The committee met, pursuant to notice, at 4:00 p.m. in room 406, Dirksen Senate Office Building, the Honorable Barbara Boxer [chairman of the committee] presiding.

Present: Senators Boxer, Vitter, and Cardin.

STATEMENT OF THE HONORABLE BARBARA BOXER, A UNITED STATES
SENATOR FROM THE STATE OF CALIFORNIA

Senator Boxer. This briefing will come to order. This is not an official hearing, it is a briefing, so we will be a little bit more informal, but we will still have opening statements, if members want to make it, and then we will move to the panel, and we will go back and forth.

I want to thank the Inspector General, Arthur Elkins, very much, and the Assistant Inspector General for Investigations, Patrick Sullivan, for your excellent work that you have done regarding the investigation of John Beale, who, on Friday, pleaded guilty to theft of Government property. I also want to express my deep appreciation to Administrator Gina McCarthy, who raised concerns about John Beale's actions, and it was her suspicions about him that led to this investigation.

John Beale was a career employee at the EPA who was hired as a consultant in the 1980s during President Reagan's Administration, and then he became a full-time EPA employee during the George H.W. Bush Administration. John Beale's

pattern of deception and fraudulent behavior was truly outrageous. In fact, according to the Department of Justice, during the George W. Bush Administration, he lied to a supervisor that he was assigned to an interagency special advisory group working on a project with the CIA; he took off approximately 102 consecutive days under the auspices that he was working for the CIA; he failed to report to the EPA offices for approximately six months, without even submitting a leave request; and he lied to his supervisors that he was working on a research project or working for "Langley;" he received retention incentive bonuses many years beyond when they should have expired; he obtained a free parking space by falsely claiming he had contracted malaria while serving in Vietnam; and he traveled to California to visit family under the auspices of a research project for the EPA.

Honestly, it is hard to imagine such a con man going on since the Bush Administration.

John Beale's fraudulent activities occurred from about 2000 until 2013, and his pattern of deception and illegal activities happened under the administration of both Republican and Democratic presidents. It was not until Gina

McCarthy became suspicious of his status as an EPA employee that an inquiry was even made. When Gina determined that John Beale was still on the EPA payroll, after he had alleged retired, she referred the matter to EPA's general counsel. It was Gina McCarthy's actions during the Obama Administration that led to this investigation, his plea agreement, and the return of stolen money to the American taxpayers.

The purpose of today's briefing is to ensure we have the opportunity to question the IG and his staff on the Beale investigation. I understand that the IG initiated review and audit upon learning of this matter to ensure nothing like this extraordinary conduct is ever repeated. I also understand that EPA has been conducting an ongoing review of employee pay and travel reimbursement systems and has begun an effort to strengthen oversight of the Agency's internal controls.

So when my ranking member comes, I will call on him to share his views, but I can't tell you how pleased I am to have you here. So I think we will get started and then members can take their opening statements when they come, plus ask questions. We will give everyone 10 minutes at

that time.

So let's hear from you, Mr. Elkins.

[The prepared statement of Senator Boxer follows:]

Mr. Elkins. Senator Boxer, if I could, I would like to ask that Mr. Sullivan start, because he will go over the facts of the investigation, and then I will cover the facts related to the audit.

Senator Boxer. Absolutely.

Mr. Elkins. Thank you.

Senator Boxer. Please proceed, Mr. Sullivan. Again, thank you.

STATEMENT OF PATRICK SULLIVAN, ASSISTANT INSPECTOR GENERAL
FOR INVESTIGATIONS, U.S. ENVIRONMENTAL PROTECTION AGENCY

Mr. Sullivan. Good afternoon, Chairman Boxer, Ranking Member Vitter, and members of the committee. I am Patrick Sullivan, Assistant Inspector General for Investigations at the EPA. Thank you for inviting me to appear before you today to discuss in further detail my office's investigation into the activities of John Beale while he was employed in the EPA's Office of Air and Radiation, also known as OAR.

The EPA Office of Inspector General's investigation of this case has included more than 40 interviews, the review of thousands of documents, and coordination with many Federal law enforcement agencies. On September 27th, Mr. Beale pled guilty to one count of theft of Government funds.

The activities relevant to this case began in 1988, when Mr. Beale was hired as a consultant to EPA by his close friend, Robert Brenner, the then-Director of OAR's Office of Policy, Analysis and Review, and continued until Mr. Beale's retirement in April of 2013.

Our investigation revealed that during this 25 year period Mr. Beale engaged in the following misconduct: false official statements, timecard fraud, incentive retention

bonus fraud, travel voucher fraud, false personation of a Federal official, and misuse of an official Government passport.

Mr. Beale's official personnel file contains numerous misleading and false statements, including a claim that he worked for a U.S. Senator.

For a period of 22 years, Mr. Beale received a retention incentive bonus amounting to 25 percent of his salary. Evidence suggests Mr. Beale was only authorized to receive this bonus for six years, costing the Government approximately \$500,000.

Mr. Beale's work on the Clean Air Act in the early 1990s gained him significant prestige. Starting in 1994, he began the false impersonation of a CIA employee, lying even to his wife and closest friends, in addition to EPA colleagues. He told OIG investigators that he perpetrated this lie "to puff up the image of myself."

The investigation revealed Mr. Beale was absent from the EPA for long periods of time between 2000 and 2013 under his alleged CIA cover. During this time, Mr. Beale lied to several high ranking EPA officials about his work for the CIA, including former Assistant Administrators for OAR, Jeff

Holmstead and Gina McCarthy. Subsequent investigative interviews revealed that Mr. Holmstead shared Mr. Beale's claimed CIA status with other EPA executives and it became "an open secret" in the EPA that Mr. Beale worked on secret assignments for the CIA.

When Gina McCarthy became AA for OAR in 2009, she was told during her orientation process, and subsequently by Mr. Beale himself, that he worked for the CIA. Mr. Beale told us that his false statements to EPA executives "made the lie kind of official or sanctioned" because they all believed him.

Additionally, an executive assistant who worked for Mr. Beale recalled that he told her he needed to stay on with the CIA until his replacement, who had been captured and was being tortured in Pakistan, had recovered. The executive assistant then responded, "John, that is what movies are made of."

When interviewed by OIG investigators, Mr. Beale admitted to taking off a total of two and a half years, six months in 2008 and two years between 2011 and 2013, for non-existent CIA work, at a cost to the Federal Government of approximately \$350,000. Mr. Beale also stated that during

these periods he actually was working around the house, riding his bicycle, or reading books.

Concurrent with his frequent absences from EPA, Mr. Beale received substantial cash awards, including a Presidential Rank Award of \$28,201, all on top of his salary and the 25 percent retention incentive bonuses.

Mr. Beale perpetuated the lie that he had contracted malaria in Vietnam during his service in the U.S. Army, using it both as another reason for his frequent absences and to obtain a parking space subsidized by EPA for people with disabilities. Mr. Beale never had malaria and never served in Vietnam.

Over time, the parking space cost the Government approximately \$18,000.

Mr. Beale also committed travel-related fraud. For example, investigators were able to confirm more than \$87,000 in charges he submitted between 2005 and 2007 for trips to California were fraudulent. On his travel authorizations and vouchers, Mr. Beale had listed trips to Los Angeles, as well as other domestic and foreign cities, to work on an alleged research project. In reality, he has since admitted his trips were unnecessary.

As another example, Mr. Beale usually stayed in hotels that far exceeded the allowable Government lodging rate. In one instance he charged the Government \$1,066 per night for a hotel in London for four nights, even though he had the opportunity to stay at a different hotel for only \$375 per night. When confronted with this overage by one of our investigators, Mr. Beale stated, "Even I am outraged at this."

From approximately 1998 until his retirement in 2013, Mr. Beale claimed that he had a back injury requiring first class airplane accommodations when he traveled for EPA official business. He provided medical documentation from a chiropractor to support his claim. Due to Mr. Beale's undertaking extensive physical activities and his many other deceptions, his claim is dubious, at best.

Mr. Beale's first class airfares were often more than five times the amount of a coach fare. In one case, when he traveled from Washington to London, his first class ticket was 14 times higher, \$14,000 instead of approximately \$1,000 for a coach ticket.

Mr. Beale was never held accountable for his spending on these trips. When interviewed, those responsible for

approving his travel vouchers acknowledged that the charges he submitted often seemed excessive, but they never questioned him about them because he was a highly respected EPA senior official and because, based on his work for the CIA, they trusted his word.

The executive assistant interviewed by investigators said that she had brought concerns about the excessive nature of Mr. Beale's travel expenses to her supervisor, who told her not to question them.

In addition, we determined Mr. Beale traveled overseas multiple times for personal reasons using an official Government passport, in violation of Federal law.

In September 2011, a retirement party was held on a Potomac River yacht for Mr. Beale, Mr. Brenner, and a third EPA employee who announced a joint retirement. Senior ranking EPA executives, including Ms. McCarthy, attended. During interviews with OIG investigators, Ms. McCarthy and several other employees stated they believed Mr. Beale had in fact retired from EPA. On March 29th, 2012, Ms. McCarthy was informed via email by a member of her staff that John Beale was still on the payroll and had not retired. She responded, "I thought he had already retired." Mr. Beale

officially retired from the EPA on April 30th, 2013, after receiving pay and benefits for approximately another year and a half after his "retirement party."

As you will hear in more detail from Mr. Elkins, sitting next to me, Ms. McCarthy referred concerns about Mr. Beale's potential criminal conduct to EPA's Office of General Counsel on or about November 1st, 2012. Three and a half months later OGC reported the misconduct to us.

Our Office of Audit has begun research into the underlying causes and internal control weaknesses at the EPA brought to the forefront from this case. My office continues to continue the extent and potential administrative misconduct of other senior level EPA employees whose failure to exercise due diligence allowed this fraud scheme to occur and continue unchecked for as long as it did.

That concludes my statement. I would be pleased to answer your questions. Thank you, ma'am.

[The prepared statement of Mr. Sullivan follows:]

Senator Boxer. Thank you.

Mr. Elkins, do you want to do an opening statement as well?

Mr. Elkins. Yes, I would like to.

Senator Boxer. Please.

Mr. Elkins. Thank you.

STATEMENT OF ARTHUR ELKINS, INSPECTOR GENERAL, U.S.
ENVIRONMENTAL PROTECTION AGENCY

Mr. Elkins. Good afternoon, Chairman Boxer, Ranking Member Vitter, and other members of the committee. I am Arthur Elkins, Inspector General of the U.S. Environmental Protection Agency. I am pleased to brief the committee about the second part of the story, namely, the audit work that ensued as a direct result of the OIG's criminal investigation of former EPA employee John C. Beale, who pled guilty on Friday, September 27th, 2013.

Thank you for allowing me the opportunity to share with you a specific example of how the OIG safeguards the EPA and the Chemical Safety and Hazard Investigation Board from fraud, waste, and abuse through independent oversight of their programs and operations.

After the OIG briefed his staff, Ranking Member Vitter stated, on August 27th, 2013, that this matter raises a number of questions about the integrity of the process that administers EPA's workforce payroll and benefits, and requested that the OIG immediately launch an investigation into the Agency's policies and processes that facilitated Beale's fraud, and to make recommendations to ensure that

this does not happen again.

The Assistant Inspector General for Investigations, Mr. Sullivan, requested audit assistance to address areas identified as potential EPA systematic weaknesses during the investigation of John Beale. The areas related to: EPA's retention bonuses, the statutory annual pay limit, EPA's first class travel, EPA's process for approval of foreign travel, EPA's vetting process for new employees, time and attendance issues, timely referrals of potentially criminal allegations to the OIG, and authority of EPA's Office of Homeland Security.

The Office of Audit was assigned to look into all the areas listed in Mr. Sullivan's request. On September 11th, 2013, a notification letter was sent to the Agency stating that the OIG plans to begin preliminary research on various administrative areas as a result of recent actions taken against a former EPA employee.

We are currently performing work to address the first part of Ranking Member Vitter's request to look into the policies and procedures that had facilitated Mr. Beale's fraud. We have reviewed the OIG Office of Investigations' case file to determine how the fraud took place; what

internal controls existed; what controls may need strengthening; and what controls were compromised, circumvented, or overwritten.

We are conducting interviews and reviews to acquire any additional information that was not included in the Office of Investigations' case file. We are coordinating this with the Office of Investigations so we do not compromise any active investigations. The interviews are with Office of Air and Radiation and Office of Administration and Resources Management Personnel.

Upon completion of interviews and reviews, we will provide a letter to the ranking member, as requested in his August 27th letter, addressing the facts concerning how the Beale fraud occurred. The estimated date for the issuance of this letter will be October 31, 2013, barring, of course, no shutdown of the Government and the cooperation of the EPA. Any shutdown or lack of cooperation will delay the issuance.

We just started our preliminary research on the second part of the ranking member's request. Typically, it takes three to six months to issue the preliminary results of the audit, and it takes nine to twelve months for the final

report to be issued. However, if significant issues are discovered, the issuing of the final report may take longer. We will keep the committee updated on the audit's estimated completion.

Further, this audit may uncover other issues that I have not detailed this morning. The Office of Audit will continue to look at the EPA to ensure that situations similar to Mr. Beale are not occurring in other locations. Accordingly, we may also issue early warning reports to EPA concerning the internal controls surrounding the Beale matter. At this time we may issue reports on time and attendance and travel as they relate to Beale.

The investigation of John Beale has also resulted in several investigations related to administrative matters. As these are ongoing investigations, I am unable, at this juncture, to discuss them, but will do so when I can.

My briefing today highlights the OIG's commitment to continue to shine a light on EPA and the CSB, and to guarantee that our tax dollars are being well spent. The OIG clearly represents a great value to the American taxpayer. I ask the committee to please keep in mind that additional budget cuts may force us to focus on statutory

work and reduce discretionary work, such as requests from Congress to investigate agency programs or actions.

In conclusion, I would like to reaffirm the OIG's commitment to add value and assist the Agency in accomplishing its mission of safeguarding the health of the American people and protecting the environment. We take very seriously our mandate to promote economy, efficiency, effectiveness, and prevent and detect fraud, waste, and abuse through independent oversight of the EPA's programs and operations.

Chairman Boxer, Ranking Member Vitter, and other members of the committee, I would be pleased to answer any questions you or the members may have. Thank you.

[The prepared statement of Mr. Elkins follows.]

Senator Boxer. Thank you.

So I have given my five minute opening and neither of my colleagues has, so you can either take five minutes now, five minutes, then we will go to questions, if you want to. I can take five minutes of questions and then you can have ten minutes. What appeals to you more?

Senator Vitter. Madam Chair, I am just going to make a one minute opening and then reserve the rest for questions.

Senator Boxer. Oh, sure. Sure.

STATEMENT OF THE HONORABLE DAVID VITTER, A UNITED STATES
SENATOR FROM THE STATE OF LOUISIANA

Senator Vitter. So, as an opening, let me just submit
for the record my letter from today to the distinguished
chairwoman, and it urges a full hearing on this matter.

[The referenced information follows:]

Senator Vitter. But also I want to underscore something suggested by Mr. Elkins. I think this has major implications for management at EPA. From what I understand, this is not the whole iceberg; this may be the tip of the iceberg. So I urge that full hearing. I urge Ms. McCarthy and Mr. Perciasepe to be part of it, and I urge us to look at important management issues, including in that hearing, as we go forward.

And I will reserve the rest of my time for questions. Thank you.

[The prepared statement of Senator Vitter follows:]

Senator Boxer. Yes. I want to say I am very interested in doing a hearing. We will have to have people from the George W. Bush Administration, as well as the current one. Most of this took place during that period of time, including the \$28,000 award, is my understanding.

Is that correct, sir?

Mr. Sullivan. Yes, ma'am.

Senator Boxer. Thank you.

So absolutely let's see. If we have to get Mr. Johnson, we will work together on getting the folks that were there, Mr. Holmstead and others. So we will work together on getting those folks.

All right, so let me start it off.

Who was the first senior level EPA official to raise concerns about Mr. Beale? I would ask either of you.

Mr. Sullivan. Madam Chair, that would be then-Assistant Administrator Gina McCarthy.

Senator Boxer. So before that no one else had ever raised the matter with you or your office?

Mr. Sullivan. Not to our knowledge, that is correct, Madam Chair.

Senator Boxer. Okay. I think it is important, because

I have heard people blame this on Gina McCarthy, when she was really one of the heroes, as you are. She noticed something was wrong, so make sure I understand. She went to a retirement party for this con man, is that right?

Mr. Sullivan. That is correct.

Senator Boxer. So he had a retirement party and then he was still pulling down checks?

Mr. Sullivan. Yes.

Senator Boxer. And that is what tipped her off to this con.

Mr. Sullivan. Approximately six months, six to eight months after the retirement cruise, a staff member brought to her attention that Mr. Beale was still on the payroll, and she replied, "I thought he'd already retired." Then, subsequently, she launched other inquiries within the Agency.

Senator Boxer. Good. At what point, Mr. Sullivan, did Mr. Beale finally admit he did not work for the CIA?

Mr. Sullivan. That was approximately two months after we began our investigation. He consulted his own attorney and we negotiated an interview through the U.S. Attorney's Office with Mr. Beale and his defense counsel, and initially

the defense attorney told the Assistant United States Attorney that Mr. Beale did in fact work for the CIA and asked us to resolve it.

Senator Boxer. Who did?

Mr. Sullivan. Mr. Beale's attorney told the AUSA that Mr. Beale did in fact work for the CIA. So then the AUSA contacted us and we worked with the CIA Office of Inspector General and we arranged for Mr. Beale to come to Langley in a secure room to be interviewed with a representative of the CIA, our agents, Mr. Beale, and Mr. Beale's defense counsel. After we made that offer through the U.S. Attorney's Office, a day later, approximately a day later Mr. Beale's defense counsel came back to the U.S. Attorney and said, that won't be necessary, my client has admitted he does not work for the CIA.

Senator Boxer. This is like Alice in Wonderland, or worse. Catch Me If You Can, I guess more like that.

Mr. Sullivan. Yes.

Senator Boxer. Mr. Sullivan, isn't it true that Mr. Beale lied time and time again from 2001 to 2007, during the Bush Administration, about serving in the U.S. Army?

Mr. Sullivan. Yes. He lied continuously throughout

his EPA career, based on our investigative results. Not just in that period of time, Madam Chairman.

Senator Boxer. Okay, so the entire time, ever since he started he was a con.

Mr. Sullivan. There is indication that --

Senator Boxer. In 2000? We think he started the con in 2000?

Mr. Sullivan. No. By his own admission to us, he started the con in 1994.

Senator Boxer. In 1994?

Mr. Sullivan. Yes.

Senator Boxer. And it didn't come to an end until 2012.

Mr. Sullivan. In 2013, actually.

Senator Boxer. In 2013. Brother. Is anybody else implicated in what he did, as far as you know? Anyone part of this con, knew about it, covered up for this guy, shared some of the money, the things that he did?

Mr. Sullivan. Madam Chairman, our investigation revealed to date no evidence of anyone else being criminally involved with Mr. Beale. However, there are clearly some administrative issues, failure to do due diligence and such,

that we are looking at from an administrative side, not the criminal side.

Senator Boxer. Yes.

Mr. Sullivan. But, to date, we have no evidence that anyone else is involved criminally in this matter.

Senator Boxer. So you would say he was a lone wolf in terms of the con.

Mr. Sullivan. I haven't used that term, but I would agree with that assessment. That is correct.

Senator Boxer. Did any senior level officials during the Bush Administration or the Clinton Administration raise concerns about Mr. Beale's actions?

Mr. Sullivan. Not to our knowledge.

Senator Boxer. So the only one is Gina McCarthy, under this Administration.

Mr. Sullivan. To our knowledge, that is correct.

Senator Boxer. Okay. Mr. Sullivan, is it true that in 2002 Mr. Beale lied about contracting malaria while serving in the U.S. Army so he could obtain a special parking space? I think you said that in your opening statement.

Mr. Sullivan. Yes, Madam Chairman. On or about 2002 he applied for the parking place, the handicapped parking

permit, but his lie was continuous. I can't tell you he started lying about malaria and service in Vietnam in 2002, but that was when he was able to obtain the handicapped parking place.

Senator Boxer. Is it also true that in 2001 Mr. Beale told managers at EPA that he would need to take one day off a week because he was assigned to an interagency special advisory group working on a project with the CIA?

Mr. Sullivan. That is correct.

Senator Boxer. That was in 2001?

Mr. Sullivan. Yes.

Senator Boxer. That was under the Bush Administration?

Mr. Sullivan. Yes, ma'am.

Senator Boxer. W? Is it true that in 2001, under the Bush Administration, the EPA manager agreed to Beale's request for one day off to participate in this project?

Mr. Sullivan. Yes.

Senator Boxer. Is it also true that between 2005 and 2007 Mr. Beale took five trips worth tens of thousands of dollars that he falsely charged the Government?

Mr. Sullivan. Yes. We estimate it was actually \$87,000 in fraudulent travel vouchers, and they were all

trips to Bakersfield, California to visit his elderly parents.

Senator Boxer. Talk to me a little bit about this \$28,000 award. Who gave him that award?

Mr. Sullivan. That was signed off on by Mr. Holmstead, the then-assistant administrator. It is called the Presidential Rank Award, and that was in, I believe, 2006. I could give you the exact date for the record, but I believe it is 2006.

Senator Boxer. And in the course of your investigation did you find out what Mr. Holmstead said as to why this man deserved this award and the cash?

Mr. Sullivan. We never interviewed Mr. Holmstead about the specific Presidential Rank Award. We found out about that after we did the interview with Mr. Holmstead, so we never actually questioned him about the presidential award.

Senator Boxer. Well, I look forward to questioning him about that. And was that award signed by George W. Bush?

Mr. Sullivan. I haven't seen the award, Madam Chairman, but that is my understanding.

Senator Boxer. That it was a presidential award.

Mr. Sullivan. Presidential Rank Award, which is common

for senior executives in the Federal Government.

Senator Boxer. I am sure the President had no knowledge of it. I am just saying this man had quite a story going on.

I just want to thank you, Mr. Elkins, for answering the call of my ranking member that you look at what is going on in this Agency for all these years that you don't catch something like that. I mean, I would hope if someone says I am sick and I need this and that, you get a note about it from the doctor or do something. I mean, we learn that when we are in school. What is going on? So you are now, at the ranking member's urging, and I support what he is urging, you are looking at systemic problems at the Agency that you think need review. I saw that Gina sent out an initial letter to her managers attaching, I believe, some of your comments. Or is it Mr. Sullivan's comments? And telling the managers to get back because they have to change the way they do things. So I think that when we have our hearing, we will focus in on what the administrator is doing at this time.

But I just want to say to both of you, you are playing a really important role. I am so grateful to you. And I

don't want this Government to shut down, because I think we need more of your work. If you now can't go to work or you don't have a staff to help you, this thing is going to get delayed, and it means that criminals like this guy, con men and women, I can't only say it is con men, are going to take advantage, because not everybody is good, not everybody is ethical, not everybody gets it, that you are working for your Country, you better do the right thing. So I just want to say I hope that things work out.

I know that Senator Cardin feels so deeply about this because he has so many employees. They are about five percent of the workforce. We have, in California, about 169,000 Federal employees; probably more than any State, but not as a percentage of our population. As I told my colleague, we didn't become a State until 1850, so we are a little bit not as Washington-centric.

But I just want you to know that all of us, I think regardless of party here, are so proud of your work and we want you to continue your work, and we will make changes at the EPA and any other agency that we oversee. Thank you very much.

I turn to my ranking member.

Senator Vitter. Thank you, Madam Chair.

I also applaud your work and encourage you to keep at it. And just to respond to some of the suggestions from the chairman, I am not trying to suggest this is some Obama travesty versus a Bush travesty. I think this is a big serious issue of EPA mismanagement and lack of controls. And I think that is still a very real danger and issue because this is not the only case going on, as I believe you all know.

Mr. Sullivan, with that in mind, let me go back to some of the questions. Is it correct that Ms. McCarthy contacted human resources about Mr. Beale's non-retirement in April 2012?

Mr. Sullivan. That is correct, Senator.

Senator Vitter. And then, after that, when did she first report her suspicions about something being awry?

Mr. Sullivan. Well, I don't know exactly what transpired with the human resources' own internal review. I do know that on or about November 1st of 2012 Ms. McCarthy had a meeting with the Office of General Counsel and expressed her concerns about potential fraud on the part of Mr. Beale and suspected he did not work for the CIA, and at

that time general counsel referred it internally to another entity called Office of Homeland Security, and we were not informed until February 11th of 2013.

Senator Vitter. Okay. Now, let's go through that process. Is that normal and appropriate under EPA guidance for this sort of incident to be reported first to Office of General Counsel?

Mr. Sullivan. That is not unusual. What is a little unusual is the fact that it wasn't referred to us immediately. In retrospect, it should have been referred to the inspector general immediately, but it was not.

Senator Vitter. So how long was the delay between that first report to Office of General Counsel and the report to you?

Mr. Sullivan. Approximately three and a half months.

Senator Vitter. Okay. Do you think that sequence of events and what the Office of Homeland Security did in the meantime helped or hindered your investigation?

Mr. Sullivan. It hindered the investigation, Senator.

Senator Vitter. How did it hinder the investigation?

Mr. Sullivan. Well, the Office of Homeland Security are not investigators, they have no law enforcement or

investigative authority, and they did something at the beginning of their review or investigation, they interviewed Mr. Beale immediately, which, as trained criminal investigators, we never would have done; we would have collected the evidence first and did the interview when we felt it was best to make the case, as opposed to alerting him from the beginning. But they interviewed him fairly straight on and asked him questions about his CIA handlers, which, of course, alerted him that someone had detected his scheme.

Senator Vitter. Okay. Now, Beale pled guilty to stealing about \$900,000 from the taxpayers. Is that the full amount of money you think he stole from the taxpayers?

Mr. Sullivan. No, Senator, that was based on the plea agreement between the U.S. Attorney's Office and Mr. Beale's attorney. Plus, when you go back 20 or 25 years, records are very difficult to put back together then, so it was the best effort by the U.S. Attorney's Office to come up with a figure that could be proven in the event that the case went to trial. We also know that prior to 2000 there were some incentive bonuses. That is part of the civil review, and Mr. Beale is under negotiations right now with the EPA for a

civil recovery of the incentive bonuses paid between 1991 and 1999.

Senator Vitter. Okay. In addition, Mr. Beale pled guilty to the time period 2000 to 2013, but I think you have stated, and I just want to understand, you don't think that is the full time frame of his fraud? What would you consider the full time frame of his fraud, to your knowledge?

Mr. Sullivan. Yes, Senator. The monetary fraud would date back to when the initial paperwork was filed for his incentive retention bonuses in 1991. He should have received that for only three years, but those bonuses continued through 1999. So that delta between 1994 and 1999 is clearly retention incentive bonuses, 25 percent of his salary that he was not entitled to.

Senator Vitter. Okay. Robert Brenner was a high ranking official at EPA who has since retired and seems to have been very close to Mr. Beale. Do you think Mr. Beale's fraud could have occurred without Mr. Brenner's active help?

Mr. Sullivan. We have no evidence to indicate Mr. Brenner assisted in the fraud. We have not yet had the opportunity to interview Mr. Brenner. We are hoping we will

have that opportunity, but I cannot speculate, Senator.

Senator Vitter. Okay. After Mr. Beale's alleged retirement, how long did he stay on the payroll at the senior level?

Mr. Sullivan. A year and a half, sir.

Senator Vitter. Year and a half?

Mr. Sullivan. Yes.

Senator Vitter. And during that year and a half he also continued to receive retention incentive bonuses, is that correct?

Mr. Sullivan. Yes, sir.

Senator Vitter. Okay. And, during that time, what part of EPA was he listed as an employee in?

Mr. Sullivan. Office of Air and Radiation.

Senator Vitter. Office of Air and Radiation. Okay. After all this played out, did Ms. McCarthy eventually fire Mr. Beale?

Mr. Sullivan. No.

Senator Vitter. What happened?

Mr. Sullivan. During the course of our investigation, when it was referred to us, Mr. Beale submitted his retirement paperwork request and, in fact, retired on April

30th, 2013, while our investigation was ongoing.

Senator Vitter. Does that have significance in terms of Mr. Beale's entitlement to his pension?

Mr. Sullivan. Yes. It is my understanding that once a Federal employee retires, the parent agency no longer has a hold, if you will, on the pension, it is now a matter with OPM.

Senator Vitter. Okay. If Mr. Beale had been fired, what is your understanding of what would have been the status of his pension in that scenario?

Mr. Sullivan. I do not know that, Senator. I don't want to speculate.

Senator Vitter. Okay. It is my understanding that they would be in serious doubt, if not cut off, but I will look up the law and submit that for the record, whatever the answer is.

Were the erroneous bonus payments and salary for alleged CIA work included in OPM's evaluation of his pension plan retirements?

Mr. Sullivan. Yes, sir, that is correct.

Senator Vitter. So, as far as you know, as of now, that fraudulent claim of work is still built into his

pension, which is still due as of now?

Mr. Sullivan. Yes, sir, but let me correct one thing. The incentive bonuses, under regulations, it is my understanding they are not included in the pension formula; the salary is.

Senator Vitter. Okay.

Mr. Sullivan. So you are right, for the time he did not work, that time still was credited towards his pension.

Senator Vitter. So the fraudulent salary involved in his fraudulent CIA work, which never happened, is still built into his pension and he is still due that as of now.

Mr. Sullivan. Yes. I think that is a very fair statement, Senator.

Senator Vitter. Okay. How frequent were Mr. Beale's absences for CIA work?

Mr. Sullivan. Well, they began at one day a week and they gradually grew to a point where, for a year and a half, he didn't show up. And then sometimes there were six month periods. Prior to 2000, even prior to the mid-2000s, it was very difficult for us to go back and recreate how many days he may or may not have been at the office. The records are much better the closer we get to the period of time of our

investigation. It was agreed upon, however, that he agreed in the plea negotiation that it was over two and a half years that he did not come to the office.

Senator Vitter. Okay. And for that two and a half years there was no red flag raised by anyone at EPA?

Mr. Sullivan. No. The first person that raised the red flag was Ms. McCarthy, to our knowledge.

Senator Vitter. Okay. And, again, how long were some of these absences?

Mr. Sullivan. Well, one period of time, for a year and a half he didn't show up at the office; another period of time for at least six months.

Senator Vitter. Oka. Before raising a red flag, did Ms. McCarthy ever approve any of these prolonged absences from the EPA?

Mr. Sullivan. She was aware of them based on the briefing she received. She was told, when she came in for her in-briefing, that Mr. Beale worked for the CIA. And, indeed, Mr. Beale himself told her he worked for the CIA. So she told us she believed it was a longstanding arrangement that the Agency had approved of, because she came in in 2009.

Senator Vitter. Okay. And, in total, how much of Mr. Beale's salary is attributed to this fake CIA work?

Mr. Sullivan. We are estimating approximately \$350,000.

Senator Vitter. And again, I know I am repeating myself, but I think it is important, as far as you know, as we speak, that is still built into his pension?

Mr. Sullivan. Yes, sir, that is correct.

Senator Vitter. And, as far as you know, as we speak, he is still due that pension?

Mr. Sullivan. Yes, sir, that is correct.

Senator Vitter. Did anyone at EPA challenge Mr. Beale or make an inquiry about the veracity of all these pretty wild claims? I mean, on the face of it, I assume it is not standard for somebody at EPA to be working for CIA.

Mr. Sullivan. To our knowledge, the first senior person to express concerns was Ms. McCarthy. Prior to that, an executive assistant questioned his travel vouchers, believing there was fraud involved with his vouchers, but her concerns were dismissed.

Senator Vitter. Who dismissed her concerns?

Mr. Sullivan. A person who was at the same rank of Mr.

Beale, another deputy assistant administrator who actually signed his vouchers.

Senator Vitter. And what is that person's name?

Mr. Sullivan. Well, because that person has a concurrent administrative issue we are looking at, we don't believe it is appropriate for us to reveal her name at this time.

Senator Vitter. Okay.

Senator Boxer. You can get another round.

Senator Vitter. Okay. I will wait. Thank you.

Senator Boxer. Senator Cardin, you have 10 minutes.

Senator Cardin. Well, let me thank both of you and what the inspector general does generally to enforce the laws and to make sure we get value. And I just want to share the chairman's concern as we are now about seven hours away from potential Government shutdown. The impact it would have on the work that your office does. I assume that there will be many people in your office that will not be showing up to work and, therefore, will not be doing the type of investigatory work that you are responsible to do, which will, in the end, could cost taxpayers value for their taxpayer dollars and services. Is that an accurate

statement?

Mr. Elkins. Yes, Senator, that is an accurate statement.

Senator Cardin. Well, I could give many examples, and Senator Boxer was very generous in referring to the concern that I have expressed. I do represent a lot of Federal workers and there are going to be a lot of people hurt: those who are going to be working, not sure when they are going to get a paycheck, and those who are not going to be working who aren't going to get a paycheck unless we do something about it, which I hope we do. But there are going to be a lot of people who depend upon the services that are also going to be denied value and it is going to be very costly to the taxpayers of this Country. So I thank you for your work.

Let me talk a little bit about the Beale case.

First, I want to challenge the ranking member as it relates to retirement benefits. Retirement benefits are basically a contract right, and, yes, OPM has the ability, under certain circumstances, to challenge retirement benefits, but it is not related to the way that the individual decided to terminate their service. So you can't

terminate someone's earned retirement benefits because you terminate their employment. You may have cause, you might be able to go after fraud. There are remedies here that I hope we will go after and, as I understand it, this case is far from closed, so there are still remedies that are available and I am sure OPM is looking at ways that they can recover on behalf of the taxpayers of this Country for the fraud that has been committed.

Let me also just reinforce what the chair has said about the EPA director, the administrator. Gina McCarthy recognized there was a problem. Someone should have done that a long time before now, don't get me wrong, but she took action. As a result of her action, this matter was disclosed and now Mr. Beale will be held accountable for his actions thanks to her work. And it was done, quite frankly, very early in her term as the confirmed administrator at the EPA.

I am somewhat concerned to understand, there are going to be people who try to game the system. The con artists are always there. And the real culprit here is Mr. Beale, no question about it. You mentioned, Mr. Sullivan, that the Agency's approval process was, supposedly a long time ago,

allowing Mr. Beale to work for the CIA. Did you ever track down whether anyone gave approval for his assignment to the CIA?

Mr. Sullivan. Senator, there is no record of any contact whatsoever between EPA and the CIA to confirm Mr. Beale's assertions. So, to our knowledge, the first person that ever raised the question of whether Mr. Beale worked for the CIA was Ms. McCarthy.

Senator Cardin. Well, in the 1990s and the 2000s he had signed out that he was working at the CIA, if I understand what you have been able to disclose.

Mr. Sullivan. Yes. He made the assertion beginning on or about 1994 that he worked for the CIA based on his own interview with us. The first person of a senior level that we are able to tell he disclosed this to was Mr. Holmstead in 2001. In the late 1990s and the early 2000s, before we spoke to Mr. Holmstead, we are not sure how much time he took off or how far the lie spread, but for sure he had that discussion with Mr. Holmstead in 2001.

Senator Cardin. I understand when new people come in and you are being told you work at the CIA, this person works at the CIA, you are a little bit concerned about

interfering with an operation that has to do with the security of our Country, so you might be a little bit less inquisitive when a person says that you work at the CIA. I understand that. A lot of people don't even want to acknowledge they work at the CIA. I understand that also. But there had to be some person who was responsible for Mr. Beale early in his tenure at the EPA that he reported to that should have been able to confirm an assignment to the CIA. Shouldn't there have been someone that he reported to that this should have gone off well before 2013?

Mr. Sullivan. Senator, yes, it should have happened, but it did not. At the time, he had just recently been promoted to the deputy assistant administrator level and Mr. Holmstead, or the assistant administrator, because his direct supervisor. Prior to that, Mr. Brenner had been his supervisor from his entry into EPA up until 2000, 2001 time frame.

Senator Cardin. Well, are you continuing to look at the responsibility early in his career, as to who was responsible for his supervision that allowed this to go undetected for such a long period of time?

Mr. Sullivan. That will be part of the audit review

that Mr. Elkins described, it is not part of our criminal investigation. Right now, we did the criminal investigation on Mr. Beale and we are also doing the concurrent administrative investigations where there are allegations of administrative misconduct. The overall review or, if you will, internal control issues or system failures will be in charge of by Office of Audit.

Senator Cardin. And that is what I think we want to get to. Obviously, the criminal investigation is critically important and we want to make sure that Mr. Beale is held fully accountable for his fraudulent activities. But we want to learn from this situation. We want to make sure that we have controls in place so that we know the accountability of the people who are supposedly working at an agency.

But it is very difficult to understand how this could have gone for such a long period of time, a person under the responsibility of someone at EPA. And, by the way, this could happen at any agency. I don't think this is unique to EPA. A con artist can operate in any one of these agencies. It is very intimidating to say you work for the CIA and expect someone to challenge you right away. So I understand

how a con can be done in this manner, but he had to be responsible to various people over a long period of time, and it is very difficult to understand how no one assumed that responsibility.

Mr. Elkins, I think part of your investigation, I hope, will show how we can correct that going forward to make sure that everyone has a line of control and responsibility.

Mr. Elkins. Yes, Senator Cardin. We definitely view this as an internal control weakness that we will take a look at. I also want to mention there is one phrase that we have heard throughout the course of our investigation, and that is "I just presumed." The fact or the understanding that Mr. Beale worked for the CIA seemed to be fairly common. A number of folks that we spoke to said, oh, yeah, we heard that he worked for the CIA. But the phrase was "I just presumed." No one seemed to have looked under the sheets to see if there was anything else going on. So we will definitely take a look at that.

Senator Cardin. And I can understand the CIA needing certain talents and look into different agencies to try to get help in that regard, but there had to be some supervision and line of responsibility of someone who is

assigned to a different agency to make sure that the agency that is employing that person can assure that value has been given for that person's work. There has to be some accountability within the agency itself.

Mr. Elkins. Also, Senator Cardin, it also seems a little inconsistent to say that you work for the CIA as an agent, but then let everybody know that you are a CIA agent.

Senator Cardin. That should have raised questions.

Mr. Elkins. So that should have been a red flag right there.

Senator Cardin. Absolutely. There are a lot of red flags here that should have gone off. It would seem to me, also, that someone within the agency that employed him would want to know the burden on the agency is worth the price that is being paid, so they had to have some type of an evaluation as to whether this was worthwhile, particularly for such a long period of time, and then question whether a person should have been transferred over to the CIA, rather than being on the payroll at the EPA. They have a tough enough budget. There are a lot of things that could have been done over the course, and I can understand getting away with this for a few months. I can't understand for two

decades that this type of work could have been hidden for that long a period of time.

Mr. Elkins. I share your concern.

Senator Cardin. Thank you, Madam Chair.

Mr. Sullivan. Senator, if I could. There is a directive right now, issued in the mid-2000s by President Bush, which requires the CIA, if they recruit someone or detail someone to the CIA from another agency, the CIA has to communicate that to the head of the agency and the general counsel of that agency.

Senator Cardin. When was this?

Mr. Sullivan. It is Intelligence Order 304.

Senator Cardin. Under George W. Bush?

Mr. Sullivan. Yes, under President George W. Bush. It was initiated in about 2005, 2006. So if this situation happened today and it didn't predate that order, there would be something in the process where the CIA would have to formally go to the agency, tell the agency head and the general counsel that we have recruited one of your employees to work an undercover assignment for the CIA, and only those two people would know, the head of the agency and the general counsel. But, to our knowledge, that was never

followed through on and, again, that presidential directive or intelligence order was from about 2005, 2006.

Senator Boxer. Well, that is such a key point.

Mr. Elkins, I thought that your point, if somebody goes around saying they are the CIA, you are not supposed to do that. You make a very good point. It is almost like a Monty Python movie. Would the Messiah really say he was the Messiah? There was a whole scene about that. And if somebody says they are a CIA agent, then I guess what we should say is why the heck are you telling me that; I am not cleared to even know that information. But you know what? Most people are good people and they don't think someone is going to make up something. But I think that point is well taken.

I had heard, and tell me if you have heard this, and maybe this is just idle talk, that up until the very end, before the plea agreement, that he was seeing the CIA threw me under the bus. Did you hear anything like that? Did he try to say that? I really am a CIA agent, but the CIA agent won't stand behind me, sort of like the Valerie Plame issue? If you are outed as an agent, we are not going to admit it?

Mr. Sullivan. Madam Chairman, based on our interviews,

he did subsequently, after we began our investigation, and after his attorney and the AUSA began plea negotiations, he did tell some of his friends and former colleagues that he really was still a CIA agent, but he would have to take one for the team.

Senator Boxer. He said that?

Mr. Sullivan. Yes, ma'am.

Senator Boxer. But eventually admitted it was all a con job or he never has?

Mr. Sullivan. Yes. Yes, he did admit to it. He admitted it in open court on September 27th.

Senator Boxer. Finally.

Mr. Sullivan. Yes, ma'am.

Senator Boxer. Now, in answer to Senator Vitter's question, you said that he stole \$350,000 in salary that he didn't deserve. Is that what you said, \$350,000?

Mr. Sullivan. Yes, ma'am, approximately \$350,000.

Senator Boxer. Okay. And under the plea agreement, my understanding is he is going to pay back taxpayers \$1.4 million, is that correct?

Mr. Sullivan. Well, he is going to pay back to the EPA \$886,000, which is a combination of the incentive bonuses he

did not have a right to, the travel voucher fraud, the handicap parking permit fraud, and the timecard fraud. That total of \$886,000 was based on negotiations between his attorney and the U.S. Attorney's Office. The \$507,000 is a criminal asset forfeiture penalty, where he is going to be forfeiting to the United States \$507,000. That is also part of the plea agreement. Finally, based on his plea to one count of 18 U.S.C. 641 that the Government funds, in addition to the incarceration, he is subject to a \$60,000 fine, but it will be up to the judge to impose that \$60,000 fine.

Senator Boxer. Okay, so he is going to pay back the EPA \$886,000.

Mr. Sullivan. Yes.

Senator Boxer. He is going to pay the taxpayers, in addition to that, \$507,000 to the general treasury.

Mr. Sullivan. To adjust the Justice Department Forfeiture Fund.

Senator Boxer. To the Justice Department, okay. Is it true that in or around June 2000, Beale was awarded a 25 percent retention incentive bonus for three years? The purpose of the bonus was to ensure that Beale remained with

the EPA, rather than leave the Federal Government and seek employment elsewhere, and that it was supposed to expire after 2003, but Beale received it through 2013, is that correct?

Mr. Sullivan. That is correct.

Senator Boxer. So, Mr. Elkins, from your work, what the heck happened? He got it in 2000. 2003, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen. What happened? If we give a bonus to somebody and it is three years, then in three years it is over. What happened?

Mr. Elkins. I hope to be able to answer that question for you at the conclusion of our audit. That is something that we will be taking a look at.

Senator Boxer. I mean, one would think that one would make a note; this raise only for this amount of time, and then it goes back. This is shocking, that this man got a bonus in 2000, was supposed to be for three years and it lasted for 13 years. I am assuming that is part of the money he is paying back, correct?

Mr. Sullivan. Yes, Madam Chair, that is correct.

Senator Boxer. So that was really against the law, to extend that bonus. Instead of for three years, to extend it

for 10 years is actually against the law?

Mr. Sullivan. I am sorry, ma'am?

Senator Boxer. No, no, no. But nobody was looking at this. Are there anybody else there that got bonuses that lasted for ten years that were supposed to be a three year retention bonus?

Mr. Sullivan. The issue of other employees will be examined by the Office of Audit, Mr. Elkins said.

Senator Boxer. Good.

Mr. Sullivan. But, technically, as a Government employee, you cannot receive funds you are not entitled to. And even though there is no evidence that he encouraged or forced the payroll office to give him the bonuses for those years, he still received them knowing he was not entitled to it.

Senator Boxer. He sure did. And maybe other people did as well, but we don't know yet. Is that right, Mr. Elkins?

Mr. Elkins. That is a possibility.

Senator Boxer. We don't know.

Mr. Elkins. We don't know.

Senator Boxer. Now, I want to get to this issue, which

I think was an important one raised by my ranking member. You said that outside of Gina McCarthy, who tipped off the authorities, and I am assuming the reason that counsel went to Homeland Security is he thought the guy was CIA, is that right? Would that be the reason?

Mr. Sullivan. Ostensibly, yes.

Senator Boxer. When you say ostensibly, you sound like you are not happy with that excuse.

Mr. Sullivan. Ma'am, it interfered with our investigation. They had an obligation to tell us that immediately and it did not happen.

Senator Boxer. And who do you blame for that, the general counsel?

Mr. Sullivan. I don't know anyone right now because we haven't gotten to the bottom of it yet.

Senator Boxer. But you are looking at that.

Mr. Sullivan. Mr. Elkins is looking at it.

Senator Boxer. And you think it cost you three and a half months in your investigation.

Mr. Sullivan. Yes, it definitely cost us three and a half months, plus tipped off Mr. Beale that he was under suspicion.

Senator Boxer. Bad. So Senator Vitter was questioning you and said did anyone else ever think something was wrong, and you said there was one person who questioned his vouchers.

Mr. Sullivan. Yes. She is an administrative assistant, mid-level Government employee. Every office has an employee like that. Kind of the bread and butter of the Federal workforce.

Senator Boxer. Gotcha. What year did she question those vouchers?

Mr. Sullivan. When we interviewed her, she didn't remember exactly when, but it was the late 2000s, up until the time she retired, and she retired in 2012.

Senator Boxer. So did she raise it more than once or she only raised it once and once her superior said forget it, she didn't raise it anymore, or she continued to raise it?

Mr. Sullivan. Our initial interview with her indicated she raised it a few times, and subsequently we have interviewed her again, just a few days ago, and she told us about more instances where she raised the alarm. But we still haven't sat down and formally re-interviewed her

second time.

Senator Boxer. So it sounds like it is possible that she raised it both under the Bush Administration and the Obama Administration.

Mr. Sullivan. Yes, that is possible.

Senator Boxer. That is possible.

Mr. Sullivan. Yes.

Senator Boxer. Was it the same person who said I am not interested, this guy is fine? Was it the same person in both the Bush Administration and the Obama Administration that said that it was fine?

Mr. Sullivan. No. Again, she initially told us the only person she informed about her suspicions was the deputy assistant administrator. And then Friday she told us about another person that she informed about her suspicions.

Senator Boxer. Well, would you let us know? I am very interested to know who the person was who just had this opportunity to expose a definite fraud, if these expenses were fraudulent, and put her down? I would like to know who those people are.

Is that going to be made public in your work, Mr. Elkins or Mr. Sullivan? I don't think it is criminal, but

it may be part of the audit.

Mr. Elkins. Well, Senator Boxer, at this stage I don't want to speculate because I am not quite sure what we are going to find, so I don't want to lay out the parameters of the audit prematurely.

Senator Boxer. Okay. Well, I am very interested, and I think the ranking member must be very interested as well, as to who, whether it was in the Bush Administration, we know it started there, and if it continued, I would like to know who was it that told her forget this. Was it a friend of this con man? Was it a professional person? Was it a political appointee? So I would be very interested to know. So when you do your work, if it can't be made public for reasons that have to do with legality, if you could let us know, I think we would be very grateful to you.

Well, thank you very much, and I will turn it over to my ranking member.

Senator Vitter. Thank you, Madam Chair. I also want to follow up on this because, again, it is one of the things that is just egregious, this bonus award limited by law for three years, goes on for 13 years. Who recruited Mr. Beale to the EPA in 1988?

Mr. Sullivan. Senator, that was his friend and colleague, Robert Brenner.

Senator Vitter. And they were pretty close personal, is that correct?

Mr. Sullivan. Yes, sir. Yes, sir, they were. And they are still close.

Senator Vitter. And wasn't Mr. Beale's 1991 bonus award recommended by Mr. Brenner?

Mr. Sullivan. Yes, sir, that is correct.

Senator Vitter. Now, that is supposed to be to keep somebody who you think you are going to lose because of a competitive offer.

Mr. Sullivan. Yes.

Senator Vitter. Was that first award supported by any documentation or any real job offer?

Mr. Sullivan. Well, the award was supported by paperwork submitted by Mr. Brenner in which he asserted that he confirmed there was a legitimate job offer. However, it did not contain an attached letter or other documentation from an outside firm.

Senator Vitter. So Mr. Brenner said there was, but was there any other documentation?

Mr. Sullivan. No, sir, there was not.

Senator Vitter. Okay. Was Mr. Brenner aware that Mr. Beale received this bonus, that is supposed to be limited to three years, for well beyond three years?

Mr. Sullivan. Well, we don't know because we have endeavored to interview Mr. Brenner and we have not had that opportunity yet because he retained the right to counsel. We are hoping that at some point in the near future we will be able to speak to Mr. Brenner.

Senator Vitter. Okay. Let me ask that same question a different way. Who recommended Mr. Beale for the bonus in 2000, which is nine years after the original one?

Mr. Sullivan. Mr. Brenner.

Senator Vitter. Mr. Brenner?

Mr. Sullivan. Yes, sir.

Senator Vitter. So Mr. Brenner recruited him to EPA in 1988.

Mr. Sullivan. Yes.

Senator Vitter. Recommended the bonus in 1991.

Mr. Sullivan. Yes.

Senator Vitter. Supposed to be limited to three years. Recommended the bonus again in 2000.

Mr. Sullivan. Or 2001, sir, yes.

Senator Vitter. 2001. Who signed off on that 2001 bonus?

Mr. Sullivan. The 2001 bonus was signed off on by Bob Perciasepe, who was the then-assistant administrator in the Office of Air and Radiation.

Senator Vitter. Did Mr. Perciasepe know it was way beyond the three year limit? Did he fail to look into that? What happened there?

Mr. Sullivan. No. We interviewed Mr. Perciasepe and he did not recall signing the paperwork. We showed it to him. He agreed that he did sign it, but as the assistant administrator he would rely, and every assistant administrator relies upon your subordinate SES employees. The assertion was that the offer was vetted by Mr. Brenner. Mr. Perciasepe said that he signed it with that understanding. But Mr. Perciasepe had no knowledge the award continued passed the three year mark.

Senator Vitter. Okay. So, again, Mr. Brenner seems to have vouched for that.

Mr. Sullivan. Mr. Brenner clearly recommended Mr. Beale for the award in 2001, yes, sir.

Senator Vitter. I want to underscore the seriousness of all this, because neither Mr. Beale nor Mr. Brenner is some low level EPA official; they are not some mid-level EPA official. At the height of Mr. Beale's earnings, where did he rank in terms of pay within the EPA?

Mr. Sullivan. He was one of the highest level EPA employees based on his senior leader salary and his bonuses. The last four or five years he was making in excess of \$200,000 a year.

Senator Vitter. It is my understanding that he was the highest EPA paid employee. Is that not correct?

Mr. Sullivan. I don't know if that is a fact. The auditors will be able to determine that, as Mr. Elkins alluded to. They will be looking at all those behind-the-scene records.

Senator Vitter. And at his height he was paid more than the Vice President of the United States, isn't that correct?

Mr. Sullivan. Well, he was paid in excess of the level one of the executive level. I don't think he quite made the same level as the Vice President, but he was close to it.

Senator Vitter. Okay. I want to go also to this issue

of broader concerns about management at the EPA, because I said I don't think this is a President Obama issue versus a President Bush issue. I think this is either a EPA or Federal Government mismanagement issue; complete lack of controls. Is the IG award of other time and attendance issues at the EPA?

Mr. Elkins. Senator Vitter, that will be the subject of our audit, and I look forward to responding to that sometime in the near future.

Senator Vitter. Okay, that is fine. I take that as a yes, but I am not saying you said that; I am saying that. From 2010 to 2013, your office released three reports detailing how EPA has not conducted the required workforce analysis, which indicates to me that the Agency was aware that its internal controls were vulnerable to abuse. Do you agree with that or not?

Mr. Elkins. There were definitely some internal control weaknesses available. Again, our audit will substantiate one way or the other just exactly what those internal control weaknesses were. But clearly there was something wrong.

Senator Vitter. Well, again, I am talking about past

reports, so I am not asking you to comment on your ongoing work, but there were three OIG reports from 2010 to 2013 about this sort of workforce management issue at EPA, is that correct?

Mr. Elkins. That is correct, yes.

Senator Vitter. Has EPA adopted any of the corrective measures recommended by the OIG in these reports?

Mr. Elkins. Yes, they have. It is an ongoing process.

Senator Vitter. Okay. And, real roughly, how many recommendations did you make? How many have been adopted?

Mr. Elkins. Senator Vitter, I would be glad to get back to you with that information. I do not have it at the moment.

Senator Vitter. If you could submit that for the record, just how many recommendations were made, how many have been adopted.

Mr. Elkins. Will do.

Senator Vitter. And what internal control issues have you identified as things to look at coming out of the Beale case?

Mr. Elkins. Well, Senator Vitter, as I mentioned before, the seven or eight issues would be retention

bonuses, statutory annual pay limit, first class travel, process for approval of foreign travel, vetting process for new employees, time and attendance issues, timely referrals of potentially criminal allegations to the OIG, and the authority of EPA's Office of Homeland Security would be the top areas.

Senator Vitter. Okay, that is all I have. Thank you.

Senator Boxer. Well, gentlemen, I just want to thank you so much, because at the end of the day this is a con that went on and on and on, and it finally stopped, and the reason it stopped is Gina McCarthy blew the whistle on the guy and you were involved. I am really sorry that you had a delay like that, because I think it probably was a real tipoff. But it sounds to me like you still made good on your investigation, and I think this has had an ending that is important. There is a lot of lessons here. I feel that the fact that taxpayers are getting paid back, the EPA is getting paid back is critical.

But I also say, Mr. Elkins, your work now, going forward, is critical, because it is wonderful that we are making EPA whole, but we want to make sure that we have checks and balances in place so we can never have a

situation like this. In many ways it is a lesson to all of us. If somebody says something that is a little odd, it really could be odd. As simple as that.

But there are a couple of heroes in addition to yourselves and Gina, who I think was a hero in this. This woman who blew the whistle on this guy it sounds like more than once, so I am really interested in knowing more. I don't need to know names, that is not the important point. But it would say something really upsetting if she had done this six or seven times with different people. If it was just with one person, then it arouses some suspicions that somebody else could have known about this con game. And I know you are saying at this point you don't see that, but I think your work, Mr. Elkins, might go a little deeper.

Well, you both should feel really good. I pray God that you are on the job in the morning. I am very worried about the situation. But you can count on me to try to keep this Government up and running, because I think the things we do are important, and you are certainly one example of that. So thank you.

We stand adjourned.

[Whereupon, at 5:10 p.m. the committee was adjourned.]

Senator BOXER. I am really sorry that you have been vilified by certain members; you should be lauded, as the IG lauded you, and also to point out that, you know, in an organization of 15,000, 16,000 people, whether it is public, private, the military, you are going to have some outliers, you are going to have some bad actors. But the vast majority of all these people in the private sector, in the public sector, in the EPA, in the military are fantastic. So let's just try not to brush everybody with the ugliness of a John Beale. And I thank you for doing what you did to call attention to him.

Ms. MCCARTHY. Thank you, Senator. I am incredibly proud of the folks that work at EPA.

Senator BOXER. Thank you.

We stand adjourned.

[Whereupon, at 11:23 a.m. the committee was adjourned.]

[An additional statement for the record follows:]

STATEMENT OF HON. BENJAMIN L. CARDIN,
U.S. SENATOR FROM THE STATE OF MARYLAND

Madam Chairman and Ranking Member Vitter, thank you for holding today's hearing on the President's proposed fiscal year 2015 budget for the Environmental Protection Agency. Administrator McCarthy, it is always a pleasure to see you, and thank you for being here today.

EPA's proposed budget for fiscal year 2015 outlines a fiscal plan that will enable the Agency to continue to its important work of keeping the health of citizens and the communities we live in healthy and safe.

It would be an understatement to say that EPA faces challenges in fulfilling its mission to protect the environment from factions within Congress and from the supporters of polluting industries that resent being regulated.

I want to commend the President and the Agency for its proposed budget for the Chesapeake Bay Program. I will work hard with the chairman of the Appropriations Committee to see that the request is met. Ensuring that EPA and its Federal partners that cooperate in the administration of the Chesapeake Bay Program is critical to fulfilling the goals established by the President's May 2009 Chesapeake Bay Executive Order. The President's recognition of the value of this national treasure has been a critical catalyst to improve the health of the Bay.

In addition to the soon to be 5-year-old executive order, on January 29th, the Chesapeake Bay Program issued its revised Chesapeake Bay Agreement establishing new conservation goals for the watershed as determined through a collaborative process involving Federal agencies, the six States and DC, local governments and non-governmental organizations across the region. This budget is critical to supporting the goals of the agreement.

More specifically, the funding for the Chesapeake Bay Program will allow Maryland and other Bay States to focus on:

- Total Maximum Daily Load implementation,
- Implementing Phase II of watershed planning and increasing accountability, and
- Making progress to address toxic contaminants in the Bay.

I am also pleased to see the budget's prioritization of programs to combat and adapt to the effects of climate change. Maryland faces tremendous challenges from the effects of climate change. With 70 percent of my State's population living in a coastal zone, sea level rise and increased intensity of extreme weather events pose a serious risk to the safety and economy of my State.

I do want to express concerns that for the second year in a row the Administration's budget is recommending cuts to both the Drinking Water and Clean Water State Revolving Loan Funds (SRFs). These cuts are being recommended despite ever growing, multi-billion dollar, backlogs of maintenance and repair needs for water infrastructure across the country.

We should be mindful of the need to invest in our Nation's own crumbling water infrastructure. The President's EPA budget makes deep cuts to the Clean Water and Safe Drinking Water SRFs, despite the established need for increased water infrastructure investment and the significant economic growth that would result from such investment. We take for granted the ability to turn on the tap and pour a clean glass of water. We take for granted the ability to go to our outdoor spaces and fish

and swim safely. The work of the EPA is central to this sense of safety, and robust funding for these programs benefits all Americans.

Cuts to the State Revolving Loan Funds, however, are extremely deep and will significantly impact States that are already struggling to maintain their drinking water and wastewater systems.

The reductions in the SRF funding levels will impact Maryland as well as every other State. Our Nation's drinking water and wastewater infrastructure is aging and overburdened. A number of densely populated cities are served by pipes that are at least 100 years old. These funding cuts will affect the States and municipalities that are already struggling to deal with the increased costs associated with drinking water and wastewater treatment plant upgrades. At the same time, Federal investments in water and wastewater infrastructure can yield hundreds of thousands of jobs and help grow our economy.

This year, as in years past, Senator Crapo and I are leading a letter to the Senate Appropriations Committee calling for robust funding for the SRFs to make sure that this program continues to provide adequate resources for drinking water and wastewater service providers to keep their systems working effectively. I would encourage all members of this committee to sign our letter.

Last, I want to talk about how persistent cuts to EPA's budget are contributing to the biggest decline in employee job and workplace satisfaction among large Federal agencies in 2013, sinking five spots in the Best Places to Work in the Federal Government rankings. The EPA's overall Best Places to Work score stands at 59.3 out of 100, a drop of 8.3 points, for a 10th place ranking out of 19 large agencies. Last year it ranked 5th out of 19 agencies.

Deputy Administrator Robert Perciasepe said EPA employees have a strong sense of mission, believe in the importance of their work, and will rebound from what turned out to be a difficult year. He pointed out that EPA was forced to furlough an extremely high number of employees because of the across-the-board budget cuts mandated by Congress, and reduce cash awards for high performers. He noted that the unpaid furloughs began to occur at the same time employees were taking the Federal survey that is used to compile the Best Places to Work rankings. As he put it, "The EPA's budget was constrained perhaps more than other agencies', and I do believe the furloughs were a problem at that time."

This is shameful. Our country and political leaders of both parties once held our Nation's civil servants in the highest regard. These days, in some circles, it's become politically popular to vilify Federal workers. It is the middle class families of hard-working civil servants that have shouldered a disproportionate burden of the hollow efforts to balance the budget.

Madam Chairman, I know that you understand the tremendous amount of work we have ahead of us to make the United States Government an environmental leader both at home and abroad. I also believe that this administration understands the significant role EPA plays in this effort. I look forward to working together to achieve our goals, and to hearing from Administrator McCarthy.

