EPA
United States
Environmental Protection
Agency

Science and Research at the U.S. Environmental Protection Agency

EPA Progress Report 2010

Office of Research and Development






U.S. Environmental Protection Agency
Washington, DC 20460

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EPA researchers produced more than 1,500* scientific citations in 2010, providing a wealth of "influential scientific information" and "highly influential scientific assessments" to the Nation. This work is represented in papers published in peer-reviewed scientific journals, government reports, books and book chapters, and presentations shared at scientific conferences around the world.

(*Source, EPA Science Inventory: www.epa.gov/si)

EPA United States Environmental Protection Agency

Research and Development at the U.S. EPA

EPA's integrated research programs provide the solid, scientific foundation the Agency needs to fulfill its mission to safeguard human health and protect the natural environment.

No other research organization in the world offers the depth and breadth of science and engineering expertise represented by EPA's workforce. From nanomaterials a billionth of a meter in size to the global dynamics of climate change, EPA scientists and engineers are engaged in investigations that, collectively, cover every scale of our environment and focus on the links between the environment and human health.

EPA conducts research that addresses the highest priority science needs of the Nation. The work performed by EPA scientists and their partners from colleges and universities, sister Federal and state agencies, EPA regional and program offices, and a host of other environmental and human health organizations improves the air we breathe, the water that sustains us, and the land upon which we live.

Today, EPA's integrated, transdisciplinary research program is building on 40 years of scientific achievement to help families and communities realize a brighter, more sustainable future.

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From the Assistant Administrator for the Office of Research and Development, Paul T. Anastas, Ph.D.

The Path Forward: Sustainability

In January 2010, I took office as the Assistant Administrator for the U.S. Environmental Protection Agency's Office of Research and Development (ORD) and Science Advisor to Administrator Lisa P. Jackson. It was a special honor to return to EPA, where I started my career as a staff chemist 20 years ago.

Because of my history with EPA, I knew first hand that I was re-joining an Agency known for producing excellent, innovative science and research across the entire spectrum of environmental disciplines. EPA's expert scientists and engineers work at locations across the country to understand how environmental issues—from nanoparticles smaller than the width of a human hair to far-reaching, complex systems such as global climate change—can impact all Americans. Among science organizations around the world, the breadth and diversity of EPA's research is unmatched.

There is no doubt that science and research are critical to advancing EPA's mission to protect human health and the environment. Administrator Lisa P. Jackson has said time and again that science is the backbone of EPA. Indeed, the Agency depends upon its scientists and engineers to inform all of its decisions with rigorous research, analysis and assessments of the highest caliber. We provide the sound scientific basis for Agency actions that benefit the lives of all Americans, every day.

In 2010, while continuing to advance the kinds of cutting-edge research that are the hallmark of EPA, we also took ambitious steps to ensure that we are as effective as we can be for the American people. These steps, known collectively as the "Path Forward," have ensured that all of EPA's scientific work is conducted in a way that advances the goal of sustainability. In its common definition, sustainability means meeting the needs of the current generation while preserving the ability of future generations to meet their needs. At EPA, it means doing all that we can to not only protect Americans today, but also to ensure a healthy environment for our children, their children, and beyond. Achieving this ambitious goal will require the best minds to work together across disciplines in an atmosphere of innovation and creativity. It will also require broad thinking and a holistic, "systems" perspective to ensure that our science and research today can advance EPA's mission into the future.

We are doing just that. By bringing together experts from nearly every environmental discipline, we are building upon our demonstrated excellence in measuring, monitoring and assessing environmental problems to inform and empower sustainable solutions. In 2010, we broke down traditional scientific silos by forging truly transdiciplinary research areas. We established programs to encourage transformative innovations that simultaneously reduce environmental risk and grow the economy. We developed new

ways to communicate and maximize our impact, and we engaged with experts, stakeholders, and communities like never before. We embraced the goal of sustainability and, as a result, are more effectively conducting research for human health and environmental protection across the United States.

This year also marked EPA's 40th anniversary. In honor of this important milestone, we paused to recognize some of the major EPA research discoveries that have saved lives and improved the health and well-being of all Americans—landmark studies on the impacts of second-hand tobacco smoke, lead in gasoline, and air pollution, just to name a few. In 2010, we added to that proud history with significant accomplishments in six broad areas of research: **Air, Climate, and Energy; Sustainable and Healthy Communities; Safe and Sustainable Water Resources; Chemical Safety for Sustainability; Human Health Risk Assessment;** and **Homeland Security**. At the same time, we also engaged in cutting edge research to inform issues of national significance.

Just a few of EPA's scientific achievements from the past year include:

- Agency scientists, at the request of the U.S. Congress, developed a strategic research plan to study the potential effects **hydraulic fracturing**, a stimulation process used during drilling operations, could have on drinking water resources when used for extracting natural gas supplies.
- EPA scientists quantified the harmful environmental impacts of **mountaintop mining** on Appalachian streams, supporting comprehensive new guidance issued by the Agency to protect the health of local communities.
- Throughout the year, EPA celebrated 40 years of **clean air science** in support of the Clean Air Act, highlighting findings and outcomes that have led to longer lives and healthier communities.
- Working with colleges and universities, EPA regional offices, sister federal agencies, states, local communities, Tribes, and others stakeholders, EPA scientists and engineers cultivated a number of important partnerships throughout the scientific community.
- The Agency's extramural program provided more than 66 million dollars in research grants, graduate and undergraduate fellowships, and other awards.
- EPA's Homeland Security Research program, along with partners from the Department of Energy, received a 2010 "*R&D 100 Award*" from *R&D Magazine* for developing **CANARY**, innovative water quality software that enhances a water system's ability to detect when there has been intentional or unintentional contamination.
- The next generation of environmental scientists and engineers were recognized and rewarded with the 7th Annual **EPA P3 Awards**.
- Building on cutting-edge design developed by EPA engineers and their partners, Administrator Lisa P. Jackson joined Secretary of State Hillary Rodham Clinton to announce a major new partnership to improve indoor air quality for millions of women and children through the design of cleaner, more efficient **cookstoves**.
- EPA researchers contributed science toward the revised **National Ambient Air Quality Standards**, a set of science-based standards for protecting human health from air pollution.

In the midst of this important work, EPA and its federal partners answered the call when the Deepwater Horizon oil rig exploded in the Gulf of Mexico. Our scientists, engineers, and experts from across the country mobilized immediately to do what was necessary to protect the lives, communities, and ecosystems of our fellow citizens. EPA laboratories on the Gulf coast became important response-team hubs, EPA scientists were central to informing emergency response strategies, and EPA studies provided the first toxicology tests on oil dispersants available for use in response to the BP oil spill. I am proud to work in an Agency that was able to rise to unprecedented challenges with the highest level of scientific integrity.

Whether engaged in crisis response, cutting-edge innovation, or our path toward sustainability, EPA scientists spent 2010 working to advance the Agency's mission. In 2011 and beyond, we will continue to serve Americans by conducting the science and research needed to protect their health and their environment.

Thank you,

Paul T. Anastas, Ph.D.
Assistant Administrator
Office of Research and Development
U.S. Environmental Protection Agency

This Progress Report is dedicated to

Patrick Harrington Hurd
October 16, 1983 – January 17, 2011

Air, Climate, and Energy

American communities face serious health and environmental challenges from air pollution and the growing effects of climate change, both of which are intricately linked with energy options.

Building on 40 years of achievement in air pollution research that has led to landmark outcomes—including healthier communities and longer life expectancies—EPA researchers are exploring the dynamics of air quality, global climate change and energy as a set of complex, yet interrelated, challenges.

This section highlights some of EPA's many achievements advancing Air, Climate and Energy science during 2010, including: a year-long celebration of 40 years of clean air science achievements in support of the Clean Air Act that brought researchers, stakeholders and the public together to explore past achievements and emerging research efforts; the announcement of a major new partnership to develop clean cookstoves for the developing world; the launch of a major near-roadway study investigating the links between local air pollution and asthma; the development of a model illuminating how controlling man-made sources of air pollution also may reduce compounds released into the air from vegetation; and much, much more.

Since the establishment of EPA in 1970 and passage of the Clean Air Act Amendments the same year, EPA's Clean Air Research has provided the scientific information, tools and technology to reduce and control air pollution.

Celebrating the Past, Looking to the Future: *Air Science 40*

EPA provided a year-long look at clean air science achievements and ongoing research.

2010 marked two important milestones in the nation's history of protecting human health and the environment: the 40th Anniversary of the establishment of the U.S. Environmental Protection Agency and the passage of the landmark Clean Air Act. The Agency celebrated both occasions through the *Air Science 40* program, a series of lectures, Webinars, and other public events centered on science communication and highlighting how advances in clean air and human health science have contributed to cleaning up the nation's air and improving the health of its citizens.

Throughout the year, *Air Science 40* programs highlighted four decades of clean air science accomplishments. Leading EPA scientists and their partners also shared ongoing research efforts to develop a deeper understanding of the complex, often far-reaching, new challenges the Nation and local communities face in managing air quality. Emerging issues, such as the multitude of pollutants in the air, and the complex interactions between air quality and a changing climate, were explored and shared by leading experts.

To kick off the celebration, EPA's Clean Air Research Program co-sponsored an international conference on the latest science exploring the connections between health risks, sources of air pollution and their emissions, and how those risks might be minimized. *Air Pollution & Health: Bridging the Gap From Sources to Health Outcomes* was held March 22-26, 2010, and was sponsored by EPA and its partners, the American Association for Aerosol Research, and the Air and Waste Management Association.

Following the kickoff in San Diego, *Air Science 40* continued with Congressional briefings, regional presentations, and a seminar and Webinar series. Each event provided the opportunity for EPA scientists and their partners to share the latest research efforts and findings that are adding to a 40-year foundation of achievement.

A series of Webinars and presentations was conducted by investigators from EPA-supported Particulate Matter (PM) Research Centers. The PM Centers are leading research institutes focused on exploring the links between particulate matter and human health effects.

Presentations in the series included:

- *Extrapulmonary Effects of Ambient Ultrafine Particles: Controlled Clinical and Animal Studies* (Mark Frampton, M.D., lead investigator, Rochester PM Center)
- *Ultrafine Particles and Immediate Responses of the Cardiovascular System* (Annette Peters, Ph.D., lead investigator, Rochester PM Center)
- *Novel Exposure Scenarios to Define the Health Effects of Particle Sources* (Petros Koutrakis, Ph.D., Director, Harvard PM Center, and John Godleski, M.D., Associate Director, Harvard PM Center)
- *Environment Interactions in the Association of Air Pollution With Cardiovascular Disease* (John Godleski, M.D., Associate Director, Harvard PM Center, and Joel Schwartz, Ph.D., lead investigator, Harvard PM Center)
- *Geographical Differences in PM Health Effects, Composition, and Toxicity* (Patrick Breysse, Ph.D., Director, lead investigator, Hopkins Center for PM Research)
- *Building Science for a Multipollutant Future: The Health Effects Institute (HEI) Strategic Plan* (Dan Greenbaum, President, HEI, and Robert O'Keefe, Vice President, HEI)

EPA *Air Science 40* Seminars

The EPA *Air Science 40* Seminars, co-sponsored by EPA and its partners, featured a number of presentations highlighting important clean air research findings that were shared with members of Congress and leading scientists. Seminars included:

- **Air Quality in a Changing Climate**
  What the Future Holds for the Air We Breathe
  Co-sponsored by the American Geophysical Union
- **Clean Air for All?**
  Air Quality Across Social and Spatial Lines
  Co-sponsored by the American Thoracic Society
- **Air Pollution—A Matter of the Heart**
  How Polluted Air Causes Cardiovascular Disease
  Co-sponsored by the American Heart Association
- **Breathe Cleaner, Live Longer**
  Understanding Air Pollution After 40 Years
  Co-sponsored by the American Heart Association

Since the establishment of EPA in 1970 and passage of the Clean Air Act Amendments the same year, EPA's clean air research has provided the scientific information, tools, and technology to reduce and control air pollution. 2010 was a year to celebrate those accomplishments and look toward the future.

AIR SCIENCE 40

Better Burning, Better Breathing: Cleaner Stoves

EPA and partners will continue the effort to develop safer, lower emission solid-fuel cookstoves.

On September 21, 2010, EPA Administrator Lisa P. Jackson joined Secretary of State Hillary Rodham Clinton and a number of partners to announce a major effort to combat problems associated with cookstoves. Speaking at the Clinton Global Initiative in New York, Secretary Clinton announced that the U.S. Government was pledging $53.32 million—including a $6 million contribution by EPA—for the Global Alliance for Clean Cookstoves.

Led by the United Nations Foundation, the Global Alliance for Clean Cookstoves aims to save lives, improve livelihoods, empower women and combat climate change by creating a thriving global market for clean and efficient household cooking solutions. The Alliance's goal is to create the market and distribution conditions necessary for 100 million households to adopt clean cookstoves by 2020.

EPA's involvement was in part sparked by ongoing research conducted by EPA scientists and engineers who tested a number of household cookstoves and fuel combinations for performance and air pollution emissions. The work was done to support the Partnership for Clean Indoor Air (PCIA), an association of more than 370 organizations contributing their resources and pooling their collective expertise to reduce smoke exposure from cooking and heating practices. PCIA was launched in

Better Burning, Better Breathing: Cleaner Stoves, *Cont'd.*

2002 at the World Summit on Sustainable Development in Johannesburg.

The objectives of the EPA study under the Partnership were threefold:

1. Determine if some cookstove designs have improved fuel efficiency and lowered pollutant emissions as compared with traditional "three-stone fire" (three stones placed around a fire to hold up a pot) found in many kitchens in the developing world.
2. Provide useful cookstove performance and emissions information to PCIA partners and others supplying stove technology to developing countries.
3. Compare test results using the Water Boiling Test protocol with those of a PCIA partner, Aprovecho Research Center in Cottage Grove, Oregon.

Research results from the study, presented in the paper "Solid-Fuel Household Cookstoves: Characterization of Performance and Emissions" (*Biomass and Bioenergy Journal,* February 2009;33(2)) showed that some stoves currently used in the field offer the benefits of improved fuel efficiency and lower pollutant emissions compared with traditional cooking methods. Stoves with lighter, less dense materials exposed to the heat of the fire tended to cook faster with better fuel efficiency and lower pollutant emissions.

The study provided an independent evaluation of 14 stove/fuel combinations with an emphasis on modern cookstoves designed to reduce harmful emissions and improve fuel efficiency. It illustrated the importance of testing stoves, and presented useful information for improving the design of stoves. Test results using the latest stove technology had not been reported in the peer-reviewed scientific literature before. The study also showed that stove-testing results can be replicated between laboratories, and offered recommendations for improving the ability to replicate results.

As part of the newly announced Global Alliance for Clean Cookstoves, EPA researchers and engineers will continue to advance their work, teaming up with partners across the globe to address critical areas such as stove testing and evaluation, cookstove design innovations, and health and exposure assessments to calculate the benefits of improved stoves.

Exploring the Links Between Air Pollution and Asthma

EPA scientists and partners teamed up to examine road-related air pollution and susceptibility to asthma.

Can living near a highway make you more susceptible to asthma attacks? EPA scientists, together with partners from the University of Michigan, teamed up in 2010 to examine this question through the Near-Road EXposures to Urban Air Pollutants Study (NEXUS).

Beginning in the fall of 2010, scientists began conducting a comprehensive asthma trigger study that will collect and use data from more than 60 children living in Detroit who suffer from asthma. Scientists will look at the mixture of pollutants that originate from Detroit-area highway traffic to determine how the pollution affects children with asthma. Data collected from air near major highways, as well as in homes and schools, will shed light on the mixture of air pollutants that affect asthma and overall health.

EPA scientists are working with partners from the University of Michigan and scientists from across several scientific fields to track air pollution over its entire lifecycle, from identifying its various sources to its ultimate effects on human health.

Building on lessons learned from past EPA-led research on near-roadway air pollution, NEXUS will include studies of air pollutant sources, near-roadway air pollution levels and behaviors, and indoor air quality. During the study, scientists also will compare the toxicity of various air pollutants and conduct an epidemiological analysis of the health effects of air pollution.

In addition to Detroit's many heavily travelled highways, researchers will be able to look at pollution from other sources, including coal-fired power plants, metal refineries, and other heavy industries. They will also be able to examine the mix of airborne substances (including mold, pet dander and tobacco smoke) in study participants' homes and at several schools to compare those levels with the measurements taken at outdoor ambient air quality sampling sites.

The NEXUS project is already providing a major benefit to the local community. The project has created financial opportunities for Detroit residents, employing community members in data-gathering efforts and participant interviews. The training that participants receive will prepare them for future work in scientific research.

Furthermore, families participating in the study are being given access to the data collected from their homes. Researchers are working with a partner community group—Community Action Against Asthma—to help participant families gain access to health care and information to help them reduce asthma triggers in their homes.

When NEXUS' data-collection phase ends in 2011, scientists plan to look for epidemiological patterns so they can answer such questions as: What pollutants are most strongly associated with asthma? The data also will help scientists test and improve air quality models. By linking data from the ambient sites with data collected from Detroit homes and schools, scientists will be able to better determine how the ambient air is contributing to residents' overall exposure to pollutants, and how to better predict health effects caused by air pollution.

Knowing which chemicals are the most harmful will allow policymakers to make better-informed decisions about clean air policies in their communities; targeting specific chemicals, for example, makes it easier for industry to comply with new clean air regulations.

Partnerships at Work:
To help determine the significance of near-road emissions/exposures and related health risks from mobile sources, EPA grantees developed a testing facility that allows for a controlled inhalation exposure to freshly diluted and mixed diesel exhaust.

Air Pollution: Modeling the Mix

EPA modelers and partners show how controlling man-made sources of air pollution also may reduce compounds released into the air from vegetation.

EPA researchers have discovered that controlling man-made sources of air pollution will have the added benefit of also reducing air pollution formed from compounds released from trees and plants.

Trees and plants release more than just oxygen into the atmosphere as a result of photosynthesis. They also release a variety of gases that contribute to air pollution. In fact, the planet's vegetation accounts for about two-thirds of the pollutants known as volatile organic compounds (VOCs) emitted globally.

In the study, published in the May 15, 2010, issue of *Environmental Science & Technology*, EPA researchers and partners quantified for the first time how emissions from vehicles, industry and power plants interact with natural emissions from vegetation to change the composition and makeup of chemicals in the air… for the worse.

The implications of the study are considerable, suggesting that if people can control man-made sources of emissions, they can indirectly affect the formation of naturally derived atmospheric pollutant particles.

Using computerized air quality modeling, investigators conducted simulations of natural and human-related pollution in the United States. When scientists took man-made pollutants out of the simulation, there was a 50 percent drop in pollutants from trees and plants in the Eastern United States. These pollutants, known as secondary organic aerosols (SOAs), are produced by sunlight when VOCs from trees, plants, cars, or industrial emissions interact with other airborne chemicals. SOAs are important for the formation of two regulated air pollutants, particulate matter and nitrogen oxide, a greenhouse gas.

The study suggests that roughly one-half of the "natural" SOAs in the Eastern United States form only when there is enough man-made pollution around.

The model can guide the development of strategies that can control atmospheric chemistry. Over the last 40 years, similar EPA research efforts to develop a better understanding of clean air science have led directly to policies widely credited with better air quality, which in turn reduces hospitalizations, worsening levels of asthma, cardiac events, and even deaths.

The research also can guide EPA to develop more refined and focused standards and strategies for effectively and efficiently decreasing pollution. This is just a first step in gaining an understanding of the complexity of the atmosphere. The research may have implications for future air pollution management strategies as well.

Scientists predict climate change will stimulate the growth of trees and plants and extend growing seasons, resulting in even more emissions from natural sources. By controlling man-made emissions, the impact of emissions from trees and plants may be reduced.

Expanding Atmospheric Modeling Capabilities to Protect Human Health and the Environment

EPA scientists incorporate cutting-edge science and meteorology into a widely-used air quality model.

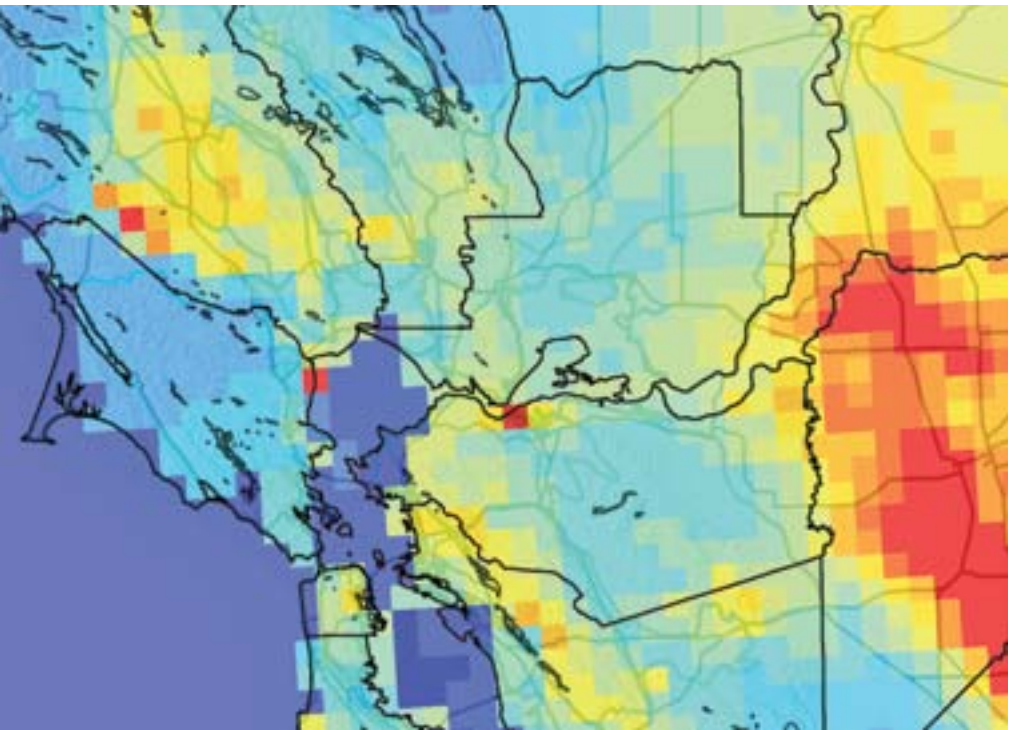
In 2010, EPA scientists worked to incorporate cutting-edge air quality science and meteorology and additional capabilities into the Agency's popular Community Multiscale Air Quality (CMAQ) model, which has been used around the world for more than 10 years to protect human health .

Slated for release in September 2011, version 5.0 of CMAQ adds a new online capability—namely a "coupled meteorology-chemistry option" —to the air quality model that is used by EPA and states for designing emission control strategies needed to meet and maintain the National Ambient Air Quality Standards. An earlier version of the model is used by the National Weather Service to produce daily U.S. ozone air quality forecasts.

The "coupled model" will better represent the physical and chemical processes occurring in the real world by properly simulating the feedbacks between meteorology and air chemistry so scientists can better understand not only how weather conditions affect the chemistry, but also how air chemistry can affect and change weather conditions.

In this new modeling framework, meteorology data are updated on the fly, allowing scientists to use the model to look at smaller, finer resolution settings, such as individual towns and cities. Furthermore, while CMAQ has been used to assess air pollution problems at regional and continental scales, this new coupled model will allow researchers to expand the spatial scale to the northern hemisphere, thereby helping to answer questions about the intercontinental transport of air pollution and interactions between air quality and climate change.

As CMAQ is already used world wide to help shape air quality management, the anticipated updates will enable regulators to better protect human health and the environment.



Modeling Shows Influence of Climate Change on Ozone Air Pollution

EPA partners show how climate change may offset some of the benefits of emissions reductions programs.

As we face the reality of global climate change, the need for new advances in modeling systems and methods for assessing the impacts of climate on air quality is increasing. Robert Harley and his colleagues at the University of California, Berkeley, recently used the CMAQ modeling system to assess these impacts on future air quality in California. This research, which is funded through the EPA's Science to Achieve Results (STAR) grant program, led to new insights about the relationship between air pollution and climate change.

Harley and his team of scientists show that climate change has the potential to offset some of the benefits of emissions reductions programs. The CMAQ system was used to simulate changes in tropospheric ozone levels resulting from future changes in pollutant emissions. By 2050, technological changes and an aggressive set of emissions controls are predicted to decrease ozone pollution. The magnitude of that decrease, however, is significantly reduced when the effects of climate change are considered. In fact, ozone levels are predicted to increase in the San Francisco Bay area.

This EPA-funded research is helping air quality managers plan to meet health-based air quality standards in the future. Poor air quality and high ozone levels already exist in many regions of California, and higher temperatures predicted with climate change could make this problem worse. Existing regulations may need updating to ensure public health is protected on a warmer planet.

Harley's work also explored the effect of higher temperatures on VOC emissions. Cars and other mobile sources are the dominant anthropogenic source of VOCs in California, and the research team two important types of vehicle-related pollution: tailpipe emissions and liquid fuel evaporation. The relative importance of evaporative sources could increase in the future as maximum daily temperatures rise.

The research demonstrates several possible influences of climate change on air pollution, and the need to consider these effects in air quality management. The air quality assessment approach developed by Harley's group can be utilized by local and state regulators to meet national air quality standards effectively and efficiently.

Air, Climate, and Energy

2010 Accomplishments – In Brief

EPA-Funded Particulate Matter (PM) Research Center Assesses Ultrafine PM Health Effects

EPA-funded research at the Rochester PM Research Center and the Southern California Particle Center found that ultrafine particulate matter (UFP) is easily transported throughout the body beyond the cardiopulmonary system. Tissue and cell analysis shows evidence for the translocation of UFP to the liver, kidneys and central nervous system. Exposure to concentrated airborne PM led to inflammatory responses and oxidative stress in key organs. Surprisingly, there is potential for UFP to cross into the circulatory and lymphoid systems, which could allow the particles to reach sensitive sites, such as the heart, spleen and bone marrow.

Age and disease were found to be critical modifying or susceptibility factors. Researchers also found that impacts on the circulatory system could be worse for those with atherosclerotic vascular disease, such as that seen in type 2 diabetes. The Rochester Center's 2010 report, *Assessment of Ambient UFP Health Effects: Linking Sources to Exposure and Responses in Extrapulmonary Organs*, integrates the results of many of the Center's PM health effects studies to show that ultrafine particles can cause significant health effects in the respiratory, vascular and cardiac systems—especially in older adults and people with atherosclerotic vascular disease.

Developing Methods for More Refined Measurements of Air Pollutants

Three EPA-funded research efforts led to the development of technologies for the continuous measurement of PM composition. Results will provide new techniques for state and local air pollution monitoring networks and for conducting intensive field studies. Accomplishments include:

- A new mobility spectrometer developed by an EPA grantee at the University of California, Davis, that can analyze distributions of molecular ions, charged particles and macromolecules or molecular clusters. The device, called Cross Flow Ion Mobility Spectrometry (CF-IMS), is lightweight, low cost and can analyze the composition of the gas phase continuously with high-mobility resolution.
- An EPA grantee at the Georgia Institute of Technology tested a cost-effective monitor that measures water-soluble components of urban aerosol. A potassium and a sodium ion-selective micro-electrode was integrated with a Particle-Into-Liquid-Sampler for online measurements and deployed near a prescribed burn in rural Georgia. New techniques for detecting the water-soluble metals iron sulfate and copper were also tested successfully. Results from the trace metals tests showed an improvement in measurement sensitivity and temporal variability over the traditional filter-based approach.

EPA-Funded Researchers Map Heat-Related Trouble Spots

EPA-funded researchers used a novel approach to develop a map showing where people are more vulnerable to dangerous heat waves.

Although heat waves and hot weather are known to lead to increased deaths and illness, what is not well understood is why some people are affected more strongly by heat than others. With the frequency of heat waves expected to increase in much of the world due to climate change, the links between heat and health become especially important.

Air, Climate, and Energy

2010 Accomplishments – In Brief, Cont'd.

A team of EPA grantees collaborated to map vulnerability to heat in the United States by analyzing 10 "vulnerability factors," including demographic data, air conditioning prevalence, vegetation cover, and diabetes prevalence, in nearly 40,000 census tracts across the United States.

The results of the study, which were published in *Environmental Health Perspectives*, (Reid CE, O'Neill MS, Gronlund CJ, Brines SJ, Brown DG, et al., 2009 "Mapping Community Determinants of Heat Vulnerability") identified some of the most vulnerable areas of the country, providing critical insight to guide further research and the formulation of strategies to protect public health.

EPA Partners Develop Models and Strategies for Smart Growth in a Changing Climate

Adopting "smart" urban planning strategies is a non-traditional pollution control strategy that has received attention from EPA grantees. Land use management and transportation policies are tools that state and local officials can employ to help mitigate the effects of climate change on air pollution.

In addition to developing air quality metrics for evaluating different growth development strategies, here are some of the critical findings:

- Road pricing and urban growth boundary policies could reduce vehicle miles traveled and ozone precursor emissions in Austin, Texas.
- A new model for developing sustainable communities was applied to a county in North Carolina to demonstrate neighborhood "livability" and air quality.
- Regional scale modeling predicted future transportation needs and land use to evaluate the impacts of climate change and, the built environment, and transportation technology choices on air quality across the upper mid-western U.S. The results confirmed substantial benefits from the Tier-II vehicle emissions regulations through 2050 and that smart growth strategies could result in significant improvements to air quality in the future.

Climate Change Predicted to Increase Flooding and Waterborne Disease Risk

Research conducted by EPA grantees investigated how climate change will impact waterborne disease risk in the Great Lakes region. The study focused on how heavy precipitation events are expected to change during the 21st century. These heavy precipitation events are associated with flooding and sewer overflow conditions that are conducive to the spread of waterborne disease.

The researchers calculated that the occurrence of precipitation events heavy enough to cause sewer overflow into Lake Michigan would increase by 50% to 120%. This could have a great impact on the beaches of Lake Michigan, especially their availability for recreational use. Similarly, given that Lake Michigan is a drinking water source for millions of people, this suggests another way in which climate change threatens human health.

Safe and Sustainable Water Resources

Seeking sustainable solutions to the complex problems facing our nation's drinking water and water resources is vital to supporting healthy humans, ecosystems and economies.

EPA's safe and sustainable water resources research provides the science and innovative technologies the Agency—and the Nation—needs to maintain drinking water sources and systems, as well as to protect the chemical, physical and biological integrity of our water. EPA scientists and engineers help provide sustainable water infrastructure, deliver safe drinking water, manage stormwater, and remove and treat wastewater, allowing its sustainable and safe reuse.

This section highlights some of the many accomplishments that EPA scientists and researchers made in 2010 to advance safe and sustainable water resources, including: the launch of a scientific program to explore the potential impacts of a stimulation method used to harvest natural gas known as hydraulic fracturing, the release of two major reports on the environmental impacts of mountaintop mining, the publication of a manual to help localities protect coral reefs, a major update to a widely used tool for helping protect the nation's rivers and streams, and much more.

Hydraulic Fracturing: Drilling for Answers

At the request of the U.S. Congress, EPA researchers prepared to lead an extensive scientific evaluation of the potential impacts of hydraulic fracturing on drinking water resources.

A convergence of factors, including rising energy prices, the national security benefits of developing new domestic energy supplies, and an economic downturn — have sparked great interest in expanding natural gas development. What's more, natural gas burns cleaner and emits less greenhouse gas per unit of energy than other fossil fuels.

With those factors already in place, a stimulation process known as hydraulic fracturing, commonly referred to as "fracking," has made it possible and profitable to unlock natural gas reserves from underground geologic formations that were previously considered economically unfeasible for natural gas development.

Hydraulic fracturing creates or enlarges cracks in subterranean rock formations. Crews send drilling shafts into the ground, and then inject a mixture of water (millions of gallons per well), chemicals and "proppants" (typically sand, or other small particles, to hold open the cracks) into the shaft at high pressure. The injected fluid cracks or enlarges fissures in the rock, allowing natural gas to flow into the well and up to the surface.

The practice of hydraulic fracturing, however, has raised concerns about its potential impact on the environment and human health, particularly on water quality and drinking water. Important questions about hydraulic fracturing include:

- What impact does removing the large amounts of water needed for high-pressure drilling have on a watershed and/or an aquifer?
- What potential impacts do associated activities and materials—such as chemicals and drilling muds, large amounts of wastewater, and fractured underground rock—have on water quality and underground drinking water supplies?

In 2010, the U.S. Congress requested that EPA formulate a plan to provide the science needed to answer these and other questions related to hydraulic fracturing.

To meet that request, EPA's Office of Research and Development (ORD) began to design a hydraulic fracturing research study. EPA scientists, engineers, and science policy experts worked together to define the most pertinent research questions, identify gaps in existing data, and illuminate research priorities. They also built a robust process to incorporate stakeholder input, including public meetings in locations close to, or in communities potentially impacted by, hydraulic fracturing activities.

To elicit ideas and suggestions from EPA's Science Advisory Board (SAB), the Agency's ORD produced the document, *Scoping Materials for Initial Design of EPA Research Study on Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources.* The SAB is an independent, external federal advisory committee called upon to provide expert council to the Agency regarding technical matters.

The SAB advised EPA on the scope of a hydraulic fracturing study, identified key research questions and provided input for making stakeholder involvement an integral component of the research program.

EPA is now implementing the hydraulic fracturing study plan.

EPA Advances Science of Mountaintop Mining Impacts

EPA researchers release two 2010 reports to support the Agency's new guidance for mountaintop mining.

On April 1, 2010, EPA announced a set of actions the Agency was taking to further clarify and strengthen environmental permitting requirements for Appalachian mountaintop removal and other surface coal mining projects.

EPA issues permits for such actions in coordination with other federal and state regulatory agencies, including the Army Corps of Engineers.

The scientific underpinning for the new guidance was led by EPA research outlined in two reports released for public comment and submitted for peer review by the EPA Science Advisory Board in 2010:

- *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields;*
- *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams.*

Mountaintop mining is a form of surface coal mining in which the natural vegetation from the upper topography of a mountain is removed, and then heavy equipment and explosives are used to level the upper sections to expose seams of coal. The sections of the mountain that are removed (called "overburden") to access the coal are pushed into the adjacent valleys for disposal.

The new guidelines clarified actions that EPA was implementing to protect Appalachian ecosystems in accordance with its mandate to uphold and enforce the Clean Water Act. *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* provides a state-of-the-science assessment on the ecological impacts of mountaintop mining and valley fill operations. EPA researchers identified and reviewed some 277 citations—including books, conference proceedings, journal articles, reports, theses/dissertations and other sources—to present a single-volume assessment of the latest science available on the aquatic impacts associated with mountaintop mining.

The analysis identifies five key impacts directly related to mountaintop mining and valley fill:

1. Springs, intermittent streams, and small perennial streams are permanently lost with the removal of the mountaintop and from burial under fill.
2. Concentrations of major chemical ions are persistently elevated downstream.
3. Degraded water quality reaches levels that are acutely lethal to standard laboratory test organisms.
4. Selenium concentrations are elevated, reaching concentrations that have caused toxic effects in fish and birds.
5. Macroinvertebrate and fish communities are consistently and significantly degraded.

The second report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams,* provides the scientific basis for using a field-data-derived, conductivity-based measurement as the benchmark for water quality to protect aquatic organisms living in Appalachian surface waters.

Conductivity is a measure of the level of salinity (salt) in the water. Because mountaintop mining operations can raise the salinity levels of nearby streams, measuring it provides an indication of the impacts on water quality by those operations. EPA scientists conducted more than 2,000 field samples to derive

EPA Advances Science of Mountaintop Mining Impacts, *Cont'd.*

a conductivity benchmark that protects 95 percent of the genera (sets of similar and closely related species) of aquatic organisms living in streams in central Appalachia.

Key findings of the report include:

- Concentrations of salts as measured by conductivity are, on average, 10 times higher downstream of mountaintop mines and valley fills than in un-mined watersheds.
- The increased levels of salts disrupt the life cycle of freshwater aquatic organisms, and some cannot live in these waters. Water with high salt concentrations downstream of mountaintop mines and valley fills is toxic to stream organisms.
- There are higher levels of the chemical selenium downstream of mining sites. Selenium exceeded the level established by EPA to protect aquatic life at more than one-half of the sites surveyed downstream of mountaintop mines and valley fills.
- By plotting the conductivity levels at which organisms are no longer observed in streams, EPA can determine a level of conductivity that results in their loss.
- A conductivity benchmark (300 microSiemens per centimeter) that protects 95 percent of the genera of aquatic organisms living in streams in central Appalachia.

The two reports were produced to provide the best available science on the environmental impact of mountaintop mining. "We will continue to work with all stakeholders to find a way forward that follows the science and the law," said Administrator Lisa P. Jackson.

Sustaining a National Treasure: EPA Released Manual to Help Protect Coral Reefs

EPA researchers produced a comprehensive guide on how to use Clean Water Act biological criteria to enhance coral reef protection.

Coral reefs are the largest living structures on the planet and have greater biodiversity than rainforests. They also are one of the most threatened marine ecosystems. Coral reefs are sensitive environments because of their highly specific requirements for temperature, salinity, oxygen, light, and nutrients. Pollution, disease, climate change, physical contact, and habitat destruction threaten these fragile ecosystems.

The President's Ocean Action Plan (2004) required EPA to develop the tools and knowledge necessary to protect coral reefs from land-based pollution using coral reef biological criteria, a tool to protect biological integrity under the authority of the Clean Water Act. This became the motivation behind the 2010 EPA publication, *Coral Reef Biological Criteria: Using the Clean Water Act to Protect a National Treasure*.

The publication was produced to provide information on the biological health of reefs to coral reef managers and other stakeholders, including residents living near reefs, tourists, fishermen, marine, and land-based industries, conservation and environmental groups, research organizations and educational institutions. It serves as a comprehensive guide on how to use the Clean Water Act and biological criteria to enhance coral reef protection efforts. The manual walks coral reef managers through the steps they should take to protect reefs and links back to what they already are doing.

A year in the making, the manual compiles an array of research performed by EPA scientists, research that is continuing to better facilitate development and implementation of coral reef biocriteria by geographic jurisdictions.

The research team that developed *Coral Reef Biological Criteria: Using the Clean Water Act to Protect a National Treasure* worked closely with EPA's Office of Water, working off the Agency's Ocean Survey Vessel *BOLD* to complete many of the reef assessments required to develop biocriteria approaches.

To further the Agency's efforts to protect coral reefs, EPA marine biologists and other researchers are continuing their work. Current efforts include research divers assessing the condition of reef corals, fish, sponges, and benthic invertebrates in the waters of the Caribbean Sea surrounding Puerto Rico and the U.S. Virgin Islands. This work will help to identify organisms and establish measurement criteria that are responsive to human activities or disturbances in the watersheds that drain into the waters containing reefs. Previous surveys have supported approaches to regional condition reporting for coral reefs, which have a patchy distribution.

Coral reefs have declined as much as 20 percent over the last 40 years and maybe as much as 80 percent in the Caribbean Sea. They are a national treasure and a vital ecosystem to protect. EPA's 2010 report and the research to develop biocriteria to help protect reefs is a promising development in protecting these national treasures.

Updated Online Resource Helps Protect Waterways

EPA researchers update tool that helps scientists from states and tribes find out what is harming plant and animal life in streams, rivers, and wetlands.

What's ailing your stream? CADDIS can help you find out. CADDIS is an EPA website developed to help scientists and engineers conduct cause and effect assessments in aquatic systems. The online application uses EPA's Stressor Identification (SI) process, supporting information, and other assessment tools to help scientists systematically evaluate the causes of harm to plants and animals in aquatic habitats. In some instances, the process produces a clear-cut answer. In other cases, it points to several possible explanations and suggests additional tests that can narrow down the possibilities.

Scientists sample the insects and other tiny creatures that live in a body of water as one way of evaluating its health. The kinds of creatures that live in healthy environments are different from those that live in troubled areas, so these counts serve as an indicator of whether or not all is well.

A new, enhanced version of CADDIS was released in September 2010. This release contains new content in each part of the site, and has been reorganized into five volumes, or topic areas:

- Volume 1: Stressor Identification—includes a new causal assessment background section, providing information on the CADDIS causal approach, causal concepts, and causal history.
- Volume 2: Sources, Stressors & Responses—includes new stressor modules for ammonia, herbicides, insecticides, pH (low and high), and physical habitat, as well as a new source module for urbanization.
- Volume 3: Examples & Applications (Examples, Databases)—includes new analytical examples, illustrating the use of different data analysis methods; provides new case studies, summarizing completed causal assessments; and provides a summary of how different states have used causal assessment techniques in their systems.
- Volume 4: Data Analysis (Analyzing Data)—includes new information on selecting an analytical approach, basic principles and issues, exploratory data analysis, basic analyses and advanced analyses.
- Volume 5: Causal Databases (Candidate Causes, Databases)—provides an expanded Interactive Conceptual Diagram application that allows users to view, create and collaborate on conceptual diagrams, as well as use those diagrams to access and link supporting literature.

Examples of improvements include the new CADDIS module on urbanization, which focuses on a source of impairment rather than a specific stressor. It provides background information on urbanization in streams and presents scenarios that investigators should consider if they suspect that urban development is significantly affecting stream quality. The update provides case studies that walk users through the assessments that different states have performed, and an interactive tool for building conceptual diagrams and linking these diagrams to evidence published by other researchers. CADDIS helps state agencies improve the condition of streams and other bodies of water by helping them pinpoint the causes of problems so that remedial actions can be targeted where they will do the most good. By providing expanded guidance and resources, the 2010 release of CADDIS will enable watershed managers to better protect the health of our nation's waters. Visit the CADDIS Web site at www.epa.gov/caddis.

Safe and Sustainable Water Resources

2010 Accomplishments – In Brief

EPA Christens New Great Lakes Research Vessel (RV)

On August 6, 2010, EPA Assistant Administrator for Research and Development, Dr. Paul Anastas, joined Congressman Jim Oberstar in the christening of the Lake Explorer II, a new vessel to support EPA research in the Great Lakes area.

The vessel was commissioned as the RV Lake Explorer II to support EPA research in the Great Lakes—a vast region with more than 10,000 miles of shoreline. The Great Lakes are the largest surface freshwater system on earth, and provide water for drinking, transportation, power, recreation, and many other uses.

The Lake Explorer II will be used to conduct applied and exploratory research on environmental stressors affecting water quality and the biological integrity of the lakes. Stresses on the lakes include toxic and nutrient pollution, invasive species, habitat degradation, air pollution, and runoff from farm chemicals on agricultural lands.

Modeling Tool Helps Beach Managers Protect Swimmers' Health

Every year, thousands of Americans swim at recreational beaches. When water is polluted, swimmers can become ill from exposure to waterborne pathogens. To reduce the number of illnesses, beach managers needed quicker ways to determine when beaches are unsafe for swimming and should be closed.

During 2010, EPA scientists developed two important tools to protect beachgoers:

- "Virtual Beach," a mathematical modeling tool to help beach managers predict concentrations of Escherichia coli, Enterococcus and other indicators of waterborne pathogens at beaches. The tool uses local data such as wave height, water temperature and rainfall to develop a model that can forecast microbial concentrations 24- to 48- hours in advance.
- A new DNA extraction method for determining the amount of pathogens present in water. The new method uses quantitative polymerase chain reaction technology to extract and quantify Enterococcus bacteria DNA, a fecal indicator, from water samples.

Responding to Aging Water Infrastructure

EPA scientists and engineers evaluate and demonstrate innovative technologies and improve the cost effectiveness of operation, maintenance, and replacement of aging and failing drinking water and wastewater treatment and conveyance systems.

During 2010, EPA began a long-term assessment of permeable surfaces to address urban stormwater management. The research is being conducted at the

Safe and Sustainable Water Resources

2010 Accomplishments – In Brief, Cont'd.

Porous Pavement Parking Lot and Rain Garden Demonstration Site located at the Agency's laboratory facilities at the Edison Environmental Center in Edison, New Jersey.

At the Demonstration Site, EPA replaced a 43,000-square-foot section of parking lot with three different types of permeable pavement and planted several rain gardens with different types of vegetation.

Over the next decade, EPA researchers will evaluate the effectiveness of each pavement type and the rain gardens in removing pollutants from stormwater. They also will measure how each type of permeable pavement helps water filter back into the ground.

Responding to the Need for Improved Microbial Source Tracking (MST) Assays

In 2010, EPA completed initial assessments of molecular assays for identifying different sources of fecal contamination in source waters (i.e., human, bovine, avian). Findings demonstrate that some assays are more robust than others in detecting species-specific indicators of pollution. Also, there are within-species factors (e.g., diet) that affect a particular assay's ability to uniquely identify sources of fecal contamination. Efforts are ongoing to more fully develop and assess MST assays in terms of specificity and sensitivity.

National Aquatic Resource Surveys Technical Support

EPA scientists and engineers provided technical support on a monitoring design, condition indicators, and field manuals for the first assessment of the biological condition of the nation's wetlands conducted by the Agency's Office of Water.

These efforts were key for the development of the *National Wetland Condition Assessment*, the first comprehensive, statistically valid scientific assessment of the condition of the nation's wetlands. The assessment's design creates a link between EPA and the U.S. Fish and Wildlife Service through the national assessments of wetland condition and the changes in that condition through time.

Sustainable and Healthy Communities

How can we meet today's needs without compromising those of future generations? More specifically, how can people protect our shared environment in a way that fosters human- health and well-being, is socially just and promotes economic prosperity?

Providing the science to answer the questions posed above is at the heart of EPA's sustainable and healthy communities research. Agency researchers and their partners from across a wide spectrum of investigative fields are working together to form a deeper understanding of the balance between the three pillars of sustainability—environment, society, and economy. Their transdisciplinary work will provide the decision tools and data that communities need to make proactive, strategic decisions aimed at a prosperous, more environmentally sustainable future. This section highlights some of the many accomplishments that EPA scientists and researchers made in 2010 to advance sustainable and healthy communities, including: embarking on a major new initiative to incorporate sustainability into all EPA programs, historic efforts to advance environmental justice through science and collaboration, the publication of a book featuring the link between ecosystem sustainability and international stability, and more.

Sustainability for the Next 40 Years—and Beyond

National Academies study to explore incorporating sustainability into EPA decisions.

As part of the activities to commemorate EPA's 40th anniversary, Administrator Lisa P. Jackson announced on November 30, 2010, that the National Academies, at the request of the Agency, has launched a study to strengthen the scientific basis for incorporating sustainability concepts into EPA's decision making.

The National Academies have convened the leading scientific experts in the Nation to build upon 25 years of sustainability science and provide an operational framework for sustainability that can be incorporated into the work of EPA.

The National Academies' National Resource Council (NRC) study will build on existing work that EPA's Office of Research and Development has conducted by strengthening the analytic and scientific basis for sustainability as it applies to human health and environmental protection within the Agency's decision-making process.

The study and report, which are to be completed by September 2011, will cover such questions as:

- What should be the operational framework for sustainability for EPA?
- How can the EPA decision-making process, rooted in the risk assessment/risk management paradigm, be integrated into this new sustainability framework?
- What scientific and analytical tools are needed to support the framework?
- What set of strategic metrics and indicators should EPA build to determine if sustainable approaches are or are not being employed successfully?
- Which assessment techniques and accounting protocols should the Agency adopt to inform ongoing efforts to improve Agency sustainability practices and procedures?

Innovative thinking and sustainable approaches will be the best tools to confront new environmental challenges as they arise. The announcement of the study and the report it will generate, known as *The Green Book*, mark EPA's commitment to innovative thinking, methods, and approaches that will give the Agency the ability to tackle current and emerging environmental challenges, and prepare the Nation to address, and perhaps even prevent, those challenges that cannot be foreseen.

EPA Hosts Historic Meeting, Sponsors Symposium to Advance Environmental Justice

Agency joins federal partners to advance a healthy environment and economy for all.

In September 2010, EPA Administrator Lisa P. Jackson and White House Council on Environmental Quality Chair Nancy Sutley reconvened the Interagency Working Group on Environmental Justice (EJIWG) in a meeting held at the White House. The meeting demonstrated the Obama administration's dedication to ensuring that all Americans have strong federal protection from environmental and health hazards.

This historic gathering marked a recommitment to advancing the mandate of Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," which states that each agency, with the law as its guide, should make environmental justice a part of its mission.

In addition to Jackson, attendees at the meeting included Attorney General Eric Holder, Department of Justice; Secretary Ken Salazar, Department of the Interior; Secretary Shaun Donovan, Department of Housing and Urban Development; Secretary Ray LaHood, Department of Transportation; Administrator Martha Johnson, General Services Administration; Carol Browner, Senior Advisor to the President on Energy and Climate Change; John Holdren, Director of the White House Office of Science and Technology Policy; Melody Barnes, Director of the White House Office of Domestic Policy; and representatives from the following federal agencies: Labor, Health and Human Services, Energy, Education, Homeland Security, Commerce, Army, Agriculture, and Defense, among others.

The role of the EJIWG is to guide, support and enhance federal environmental justice and community-based activities. By coordinating the expertise and resources of federal government agencies, the EJIWG works to identify projects where federal collaboration can support the development of healthy and sustainable communities. The EJIWG also will seek opportunities to provide green jobs and training in communities in need and promote a clean energy economy.

Scientific understanding of environmental exposures and effects is essential for supporting EJIWG's mission.

EPA, together with its partners and collaborators, began to lay the groundwork to advance that understanding back in March, 2010 when its Office of Research and Development co-sponsored a scientific symposium that featured presentations from several leading researchers in the human health and health disparities fields, as well as community activists from across the country.

Specific science recommendations developed by symposium participants included:

1. Develop and institute a new research approach/scientific framework that reflects a more holistic view of the environment and health, and produces results that can inform policies to address environmental justice concerns and environmental health disparities.
2. Incorporate community perspectives in the development of EPA's science/research agendas, as well as in data collection and the performance of exposure/risk assessments and risk management decisions.
3. Increase funding for community-based participatory and transdisciplinary

EPA Hosts Historic Meeting, Sponsors Symposium to Advance Environmental Justice, *Cont'd.*

research, with a specific focus on research that will benefit disadvantaged, underserved, and environmentally overburdened communities.

4. Advance the practice of risk assessment and management: incorporate social and other kinds of vulnerabilities, address cumulative impacts and multiple stressors, encourage the use of qualitative data, incorporate community knowledge and perspectives and account for groups that are not represented by national data.

EPA's science symposium and the historic meeting of the Interagency Working Group on Environmental Justice in 2010 marked the beginning of what are now ongoing efforts to advance environmental justice and support those efforts through the best available science. Those efforts will continue well into the future.

Sustainable Ecosystems Support Peace and Security

EPA researchers play a key role in an international workshop and new book on the link between environment and worldwide human welfare.

Environmental problems do not respect national boundaries.

Pollutants released into the air in one country can cause acid rain to fall in another. Contamination of a river as it flows through one nation can lead to fish kills or human disease in the next nation downstream. Gases emitted in one country can contribute to climate change worldwide. An act of ecoterrorism that poisons food in one nation could lead to outbreaks of disease or food shortages in numerous nations in the global food chain.

Thus, the environment is crucial to human welfare not only locally but also internationally, and threats to the environment are threats to good relationships among nations.

EPA researchers played a key role in the publication of a 2010 book about the connections between healthy ecosystems and international stability. *Achieving Environmental Security: Ecosystem Services and Human Welfare* presents the proceedings of a major international workshop on ecosystem services held at The Pell Center for International Relations and Public Policy at Salve Regina University in Newport, Rhode Island, in 2009.

The workshop was sponsored and led by EPA scientists working with the United Nations Environment Programme

Sustainable Ecosystems Support Peace and Security, *Cont'd.*

(UNEP) and the North Atlantic Treaty Organization's (NATO) Science for Peace and Security Programme.

For the international workshop, experts from five continents and 20 nations came together to share their observations and research in a wide variety of fields, including agriculture, architecture, environmental linkages to poverty, humanitarian aid, environmental management, natural disasters, remote sensing, computer modeling and public policy as they relate to ecosystem services and human health. The topics covered ranged from climate change to sustainable building design to the importance of natural landscapes to the potential impact of ecoterrorism on the food supply.

NATO has long supported scientific programs that promote world peace and security. Its many projects in this area include efforts to protect fragile ecosystems, counter man-made pollution and ecoterrorism, and assess the risks from natural disasters.

From EPA's perspective, one of the principal benefits of the workshop and new book is that they draw attention to the value of ecosystem services. EPA wants the public to understand that these types of services can be as important—and valuable—as the kind of resources to which it is easier to attach dollar signs.

EPA is the first federal agency to devote a national research program to developing a deeper scientific understanding on how ecosystem services support human well-being.

Sustainable and Healthy Communities

2010 Accomplishments – In Brief

Progress Report: Land Research Program Science Applications Through Partnerships

In 2010, EPA released *Land Research Program Science Applications Through Partnerships: A Progress Report 2005-2009*. The report presents examples of research conducted by EPA scientists between 2005 and 2009 that have contributed to addressing complex environmental cleanup issues at hazardous waste sites. The report highlights six research areas that EPA scientists and engineers have contributed to: (1) groundwater contamination; (2) contaminated sediments; (3) site characterization; (4) landfills; (5) underground storage tanks; and (6) materials management.

The report illustrates EPA's research outcomes that have led to improved remediation and mitigation of pollution at hazardous waste sites and reduced the cost of cleanup, including:

- Saving more than $100 million to remediate contaminated groundwater as a result of partnering with site managers across the country to use improved technologies.
- Assisting states with contaminated sediment assessment and remediation problems by applying new methodologies. The methods have been included in state guidance for hazardous waste cleanup.
- Applying statistical methods for site characterization in state guidance documents.
- Transferring an alternative cover technology for landfills to states, counties and federal agencies to provide a cost-effective alternative to traditional landfill covers. The technology transfer is estimated to have saved more than $200 million.
- Providing new methods and models to states to better assess and remediate leaking gasoline and gasoline additives from underground storage tanks.
- Supporting EPA's Regions and Office of Solid Waste and Emergency Response (OSWER) with technical reports and guidance on material management issues.

For a copy of the report, go to: www.epa.gov/landscience/partnerships/index.htm.

EPA Hosts Major Conference on Children's Environmental Health, Announces Support for the Next Generation of Children's Centers

On October 19 and 20, 2010, EPA hosted *Protecting Children's Health for a Lifetime: Environmental Health Research Meets Clinical Practice and Public Policy*. The objective of the Washington, DC, conference was to bring grantees, federal and professional organizations together to explore the relationship between research, clinical applications and policy implications in the field of children's environmental health.

The meeting launched the next phase of the joint EPA/National Institute of Environmental Health Sciences (NIEHS) Centers for Children's Environmental

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Health and Disease Prevention Centers (Children's Centers) program, including 12 new research grants over the next 5 years for a combined total of nearly $60 million.

EPA and NIEHS are funding six new grants for large multidisciplinary research (5-year) Centers and six new grants for (3-year) "Formative Centers."

The meeting brought together Children's Centers researchers and the North American network of the Pediatric Environmental Health Specialty Units (PEHSU) to present research findings and identify common areas of interest and potential collaborative opportunities.

An important outcome of the meeting was the focus on promoting better communication within the scientific community and with the general public. Presenters included Children's Centers researchers, PEHSU directors, Ruth Etzel of the World Health Organization, Ken Cook, President of the Environmental Working Group, and keynote speaker Annie Murphy Paul, author of the book *Origins: How the Nine Months Before Birth Shape the Rest of Our Lives*.

Developing a National Atlas of Sustainable Ecosystem Services

Understanding and quantifying the many ways in which ecosystems support and benefit people is a major challenge. Without this understanding, communities may collectively make decisions about land use and development that inadvertently diminish or destroy some of these vital "ecosystem services."

EPA scientists, in collaboration with the National Geographic Society, the U.S. Geological Survey, the Natural Resources Conservation Service, NatureServe, the City College of New York and others, are developing a National Atlas of Ecosystem Services for the contiguous United States. A demonstration intranet version of the Atlas was completed in 2010.

The Atlas also will allow users to see the effects of different land use choices and how nearby, remote, and downstream communities can be affected by local activities. When the full version is completed, the Atlas will provide an easy-to-use, Web-based mapping application that allows users to explore a visual representation of the benefits their communities reap from nature, and learn how these benefits can be conserved and enhanced for a sustainable future.

Developing Community-Based Models

Community groups have a vested interest in knowing what environmental pollutants they may be exposed to locally, but often lack information and tools to help them fully understand, prioritize, and address those risks. Communities also are faced with the challenge of guiding growth and land-use decisions in a manner that sustains the environment and provides quality of life for residents.

EPA scientists are developing community-based models and tools to assist communities with sustainable land-use decisions and identifying and prioritizing decisions about environmental pollutant exposures and risks. Two community-based models were developed in 2010, including the Community-Focused Exposure and Risk Screening Tool (C-FERST) and the Regional Vulnerability Assessment (ReVA).

C-FERST is a Web-based tool that brings together environmental exposure and

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health-related information. The tool includes maps of demographic data, environmental concentrations and human exposures for identifying "hot spots" and communities at risk. During its development, EPA scientists are listening to residents and local officials in communities to make sure the information in C-FERST is useful. Primary users of C-FERST during 2010 were EPA scientists working with partner communities. Next steps involve establishing a foundation and a design geared to the general public.

The ReVA tools compile many kinds of spatially explicit data and model results and apply new analytical techniques, allowing the user to step back and evaluate the effects of land use decisions on local and regional ecosystems.

EPA Launches a Collaborative Website for Integrated Environmental Modeling

In July 2010, EPA launched a new online tool for scientific collaboration and knowledge sharing, the Integrated Environmental Modeling Hub (iemHUB). Built by Purdue University with support from the Agency, iemHUB allows environmental researchers to analyze environmental problems and combine environmental models so that a better understanding of the environment can be developed—everything from keeping beaches clean to predicting climate effects.

EPA uses integrated modeling assessments to inform decision-making in support of its broad mission of protecting human health and safeguarding the environment. With the website, the Agency is providing a state-of-the-art resource to the environmental modeling community. The iemHUB supports the development of integrated models and their use in conducting research and informing the decision-making process.

The iemHUB was released by the EPA-supported Community of Practice for Integrated Environmental Modeling (CIEM). The Community of Practice is an informal collaborative organization that was established by EPA and other scientists to advance the state-of-the-science and technology related to integrated modeling.

More information on iemHUB is at www.iemhub.org.

Chemical Safety for Sustainability

Chemical safety is a major priority of EPA and its researchers. Moving toward a safer and more sustainable environment requires producing new and existing chemicals in safer ways and that are nontoxic. It means having the information and methods needed to make better informed, more timely decisions about chemicals. The challenges are formidable: tens of thousands of chemicals currently are in use and hundreds more are introduced every year. Many of these chemicals have not been evaluated thoroughly for potential risks to human health and the environment. Also, the consequences of use over a chemical's life cycle (from production to disposal) are not thoroughly evaluated. EPA's research on chemical safety is geared to meet this challenge.

Using innovative approaches, EPA scientists and their partners are embracing the principles of green chemistry—the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances—to produce safer chemicals. They also are integrating a diversity of scientific disciplines to develop new prediction techniques, pioneering the use of innovative technologies for chemical toxicity testing and designing tools to advance the management of chemical risks.

Chemical safety for sustainability includes research in computational toxicology, nanotechnology, endocrine disrupting chemicals, human health, and pesticides.

This section highlights some of the many accomplishments that EPA scientists and researchers made in 2010 to advance chemical safety for sustainability, including: key support to the federal response to the tragic oil spill in the Gulf of Mexico, major accomplishments in the management of chemical risk, achievements from EPA's high-tech Computational Toxicology Research Program, bringing top scientists together to advance the science of perfluoroalkyl acids, the release of two case studies exploring the broad environmental and human health impacts of nanomaterials, advances in endocrine disruptors research, the understanding of dioxin toxicity, and more.

Crisis Science: All Hands on Deck

EPA scientists provide key support to the federal response to the Deepwater Horizon oil spill.

On April 20, 2010, the mobile offshore drilling unit Deepwater Horizon, located some 40 miles off the coast of Louisiana, exploded into flames. Eleven crew members were killed, 17 were injured, and what would prove to be the worst oil spill in history had begun.

Overnight, EPA staff scientists and engineers became highly sought-after experts to inform and help formulate the oil spill-related activities of the National Response Team, an organization comprised of 16 federal departments and agencies tasked with responding to oil and hazardous substance pollution events. EPA provided full support to the U.S. Coast Guard, which served as the National Incident Commander for the federal response, leading and coordinating emergency and containment activities.

The first priority following the release of oil into the Gulf of Mexico was protecting public health. EPA scientists mobilized to monitor air quality and assess environmental conditions for potential air and water contamination. To provide Gulf Coast residents with the latest information, Agency scientists frequently collected and updated environmental data and posted it on the EPA website.

In addition to setting up emergency environmental monitoring operations, EPA researchers developed sampling approaches and Quality Assurance Plans to support data collection and ensure the transfer of reliable information for assessing environmental exposures and effects of the oil spill. Their work provided the Agency with support to identify and evaluate likely exposure pathways through which released and dispersed oil, as well as oil dispersant, could reach people and "ecological receptors" such as plankton, fish, wildlife and coastal vegetation.

EPA experts provided science to support Coast Guard decisions on cleanup and mitigation activities. A critical priority was to provide information on oil dispersants.

EPA-led studies provided the first comprehensive, standardized toxicology tests, including evaluations of potential endocrine-disrupting activity, on oil dispersants available for use in response to the Deepwater Horizon oil spill.

The tests were conducted to ensure that decisions about dispersant use in the Gulf of Mexico were grounded on the best available science. EPA began its own scientific analysis of eight dispersant products on the *National Contingency Plan Product Schedule*, a list of dispersants and other mitigating substances and devices that may be used to remove or control oil discharges.

The overall goal of actions taken in response to the unprecedented release of oil into the Gulf of Mexico was to minimize the known threat the released oil posed to the environment. Spill management strategies, practices, and technologies that were implemented include the use of sorbents, floating booms, and skimming operations to mechanically remove oil from the water; burning the oil in place; and applying dispersants.

Based on their ongoing work to support immediate and near-term remediation efforts, EPA researchers have begun designing sampling and analysis plans that can support long-term assessments of the incident, as well as the efficacy of the remediation and the recovery of the area.

Computational Toxicology Research

EPA scientists pioneer the use of high-tech computer technologies to advance the science of toxicology.

Tens of thousands of chemicals currently are in commerce, and hundreds more are introduced every year. With so many chemicals, the pace and cost of traditional, animal-based toxicity tests have meant that only a small fraction of chemicals have been adequately assessed for potential risk.

EPA's Computational Toxicology Research Program (CompTox) is working to change that. Together with their partners, CompTox researchers are working to revolutionize how chemicals are assessed for potential toxicity to humans and the environment. The CompTox Research Program conducts innovative research that integrates advances in molecular biology, chemistry, and computer science to more effectively and efficiently rank chemicals based on potential risks.

CompTox accomplishments during 2010 included:

- EPA Screened 1,000 Chemicals Using ToxCast™
  EPA's ToxCast™ program was launched in 2007 to develop a cost-effective approach for prioritizing the thousands of chemicals that need toxicity testing. ToxCast™ uses advanced science tools to help understand how human body processes are impacted by exposure to chemicals and to determine which exposures are most likely to lead to adverse health effects. ToxCast™ started screening 1,000 chemicals from a broad range of sources, including drugs donated from pharmaceutical companies, "green" chemicals and chemicals in cosmetics and other consumer products.
- International Partnership for Enhancing Chemical Safety Established
  EPA and the European Chemicals Agency (ECHA) forged a partnership in 2010 that will promote enhanced technical cooperation on chemical management activities.
  EPA will provide regulatory data (excluding confidential business information) and research from ToxCast™ to ECHA, and in return, ECHA will share the approaches and chemical data being used under the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) law that was enacted by the European Union in June 2007.
- EPA and Partners Collaborated to Improve Chemical Screening
  EPA, the National Institute of Environmental Health Sciences National Toxicology Program (NTP), and the National Institute of Health Chemical Genomics Center (NCGC) welcomed the U.S. Food and Drug Administration (FDA) to the Tox21 collaboration. Tox21 merges federal agency resources (research, funding and testing tools) to develop ways to more effectively predict how chemicals will affect human health and the environment. The collaboration was established in 2008 to develop models that will be able to better predict how chemicals will affect humans.
- EPA Opened Access to Chemical Information
  EPA released the online Toxicity Reference Database (ToxRefDB), a tool that allows scientists and others to search and download thousands of toxicity testing results on hundreds of chemicals. The database includes 30 years and some $2 billion worth of testing results that were previously found primarily as paper documents.

Embracing Change: The Next Generation of Risk Assessment

EPA developed new risk assessment practices to match the pace of scientific innovations.

In 1953, James Watson and Francis Crick presented the structure of the DNA helix in a scientific paper. Just 57 years later, scientists are predicting genetic diseases and developing treatment for previously incurable ailments.

There is no doubt that our basic understanding of disease and its causes is changing at an astonishing speed. New findings in microbiology and genetics are announced on an almost daily basis, and while this is excellent news in terms of human and environmental health, it also is important to ensure that a framework is in place to interpret these groundbreaking discoveries.

EPA is aware of this need and is leading a collaborative effort among several federal and state agencies to advance the science of risk assessment through greater incorporation of new knowledge in molecular biology. EPA's Next Generation Risk Assessment (NexGen) was launched in 2010.

New NexGen tools will evaluate toxicity at a molecular level and are intended to support both traditional risk assessment and green chemistry approaches.

The NexGen project is part of the larger EPA national research effort to develop Chemical Safety for Sustainability (CSS), the science and methods needed to produce safer chemicals using principles of green chemistry. CSS aims to increase our knowledge about the potential health effects of chemicals currently manufactured and to develop improved sustainable management strategies to deal with chemicals that pose risks to humans and wildlife.

EPA held a NexGen workshop in November 2010, at its research campus in Research Triangle Park, North Carolina, to elicit input from experts on several early-stage health effects assessments, or prototypes. Expert comments were used to refine the prototypes and help identify key points for a subsequent workshop held in February 2011.

The Agency is developing a better idea of how to proceed in the future and how to best adapt modern risk assessment to the ever-evolving science that is behind it.

The Environmental Protection Agency is embarking on an exploration of the new science and methods that are ripe for incorporation into currently emerging and future risk assessments.

This program—Advancing the Next Generation of Risk Assessment (NexGen)—is a collaborative effort among EPA's Computational Toxicology Program, the National Institute of Environmental Health Sciences and National Toxicology Program, the Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry, the National Human Genome Research Institute, and the State of California's Environmental Protection Agency.

Nanomaterial Case Studies

EPA researchers are leading the effort to study the broad implications of nanotechnology.

EPA is leading scientific efforts to understand the potential risks to humans, wildlife, and ecosystems from exposure to nanomaterials—those having at least one dimension between 1 and 100 nanometers (nm). They often have novel or unique properties that can arise from their small size.

Through innovation and discovery, EPA scientists and their partners are studying the unique properties of nanomaterials, determining their potential impacts, and developing approaches to evaluate any risks. They also are exploring how nanomaterials can be used effectively to clean up contaminants released into the environment.

In 2010, EPA released two case studies to be used as part of a larger process to identify what is known and, more importantly, what is not yet known that could be of value in assessing the broad implications of certain nanomaterials.

Nanomaterial case studies EPA released in 2010 include:

- *Nanomaterial Case Studies: Nanoscale Titanium Dioxide in Water Treatment and in Topical Sunscreen (Final)*, released in November 2010, considers two specific applications of nanoscale titanium dioxide (nano-TiO_2): (1) as an agent for removing arsenic from drinking water, and (2) as an active ingredient in topical sunscreen.

  The intent of these case studies is to characterize the current state of knowledge on the environmental impacts of nano-TiO_2 as used in these two specific applications, as well as areas where information is missing. Note that some information gaps are specific to nano-TiO_2 either as a drinking water treatment agent or as an ingredient in topical sunscreen. Other gaps may pertain more broadly to nano-TiO_2 irrespective of its application, and still other gaps may pertain even more widely to nanomaterials in general. In this way, the case studies are expected to be used in developing research strategies that will support comprehensive environmental assessments of nanomaterials.
- In August 2010, EPA released the *External Review Draft of the Nanomaterial Case Study: Nanoscale Silver in Disinfectant Spray*. This case study does not represent a completed or even a preliminary assessment of nano-silver (nano-Ag); rather, it uses a comprehensive environmental assessment that starts with the product life cycle but encompasses fate and transport processes in various environmental media, exposure-dose characterization, and ecological and health effects as well as other direct and indirect ramifications of both primary and secondary substances or stressors associated with a nanoscale silver.

  Each chapter in the external draft report includes lists of questions that reflect information gaps in that portion of the document. Some of these knowledge gaps or research needs are specific to the use of nano-Ag in disinfectant spray; others may relate more broadly to nano-Ag irrespective of its application, while still others may apply more widely to nanomaterials in general. Readers are encouraged to consider the questions listed throughout the document and offer specific comments on how individual questions or research needs might be better expressed.

Providing Answers to Chemical Safety Concerns

EPA brought top scientists together to share information about perfluoroalkyl acids.

EPA brought together leading researchers studying perfluoroalkyl acids (PFAAs)—a class of chemicals the Agency has identified as potential threats to human health and the environment—at the 3rd Biennial PFAA Days Workshop, held June 8-10, 2010, at the Agency's research facilities in Research Triangle Park, North Carolina. The workshop provided an opportunity to share recent findings and to explore potential partnerships.

PFAAs and their derivatives are used in hundreds of consumer applications, including fabric and carpet coatings (offering stain resistance), lubricants, fire-fighting foam, denture cleaners and personal products such as shampoo.

In 2009, EPA issued provisional health advisories for two of the chemicals—PFOA and perfluorooctane sulfonate (PFOS)—in drinking water and developed action plans to address several other chemicals, including the long-chain PFAAs of new concern.

EPA has one of the largest groups of scientists in the world studying PFAAs, providing expertise in many disciplines. More than 60 articles in peer-reviewed publications have been produced by EPA researchers over the past 4 years to improve the understanding of the health and environmental impacts of these chemicals.

EPA research highlights at the workshop included determining where PFAAs go in the environment after they are released. EPA researchers have developed analytical methods that enable scientists and water quality managers to determine if PFAAs are in the environment and at what concentration.

EPA scientists are testing consumer products in 12 categories to evaluate whether companies are reducing PFOA content in their products under the program. Preliminary observations show a significant reduction of PFOAs in mill-treated stain-resistant carpeting and some carpet treatment products. Other product categories are showing mixed trends. An interim report will be published in late 2011.

EPA researchers are identifying biological activity on how PFAAs cause reproductive and developmental effects in rodents. Application of biologic methods is needed to understand potential toxic effects. Researchers are examining how PFAAs may interact with nuclear receptors, specific proteins that can alter genetic code and are important to the normal development of an embryo/fetus and maintenance of homeostasis (the body's ability to regulate biological processes) in adults.

In addition, EPA researchers are exploring whether PFAA exposure plays a role in the incidence of obesity and metabolic syndrome. The chemicals are being studied because of their potential ability to influence energy metabolism (how biological fuels such as fat and sugar are being stored or converted into energy).

EPA Endocrine Disrupter Research

EPA scientists investigate chemicals that may interfere with the endocrine system to advance risk assessment and support efforts to protect human health and the environment.

EPA's endocrine disruptor research program was established to address the many industrial chemicals and pesticides that may interfere with the normal functioning of human and wildlife endocrine systems. Environmental chemicals that disrupt the endocrine system have the ability to cause a variety of problems with development, behavior, and reproduction.

EPA research addresses exposures to pesticides, toxic chemicals, and environmental mixtures of chemicals that interfere with the function of the endocrine system. Major accomplishments in 2010 include:

- Development of a Short-Term Screening Method for Thyroid Toxicants
  EPA endocrine studies on thyroid toxicants provided scientific support to the Agency's updated policy that incorporates faster, less costly screening studies into decision making. The findings provided support to waiving the requirement for developmental neurotoxicity studies for chemicals with known thyrotoxic properties.
- Development of a New Approach for Testing Environmental Chemicals for Thyroid Hormone Disruption
  EPA scientists developed a new approach for testing environmental chemicals for thyroid hormone disruption using thyroid gland explant cultures from tadpoles of the African clawed frog (*Xenopus laevis*), an aquatic species commonly used in research.
- A New Approach for Identifying Chemicals That Disrupt Male Reproductive Development
  EPA scientists developed a new approach, using a short-term *in vivo* screening assay, for identifying phthalate esters (chemicals commonly used to make plastics flexible) that disrupt male reproductive development. The assay measures alterations in fetal rat testis endocrine function and gene expression levels after five days of treatment. It is able to predict the adverse effects of the chemicals in long-term, multigenerational studies. The new approach reduces the use of animals, shortens the timeframe for hazard identification, and provides data that are useful for quantitative risk assessments for this class of toxicants.
- Toxicity Testing of Oil Dispersants after BP Spill
  Following the BP spill in the Gulf of Mexico, EPA scientists tested the acute toxicity and endocrine disrupting activity of eight potential oil dispersants. Tests were conducted using sensitive aquatic organisms found in the Gulf such as mysid shrimp (*Mysidopsis bahia*). Results confirmed that the dispersant used for cleanup, Corexit 9500a, was no more or less toxic that the available alternatives. Some of the dispersants tested contained endocrine-active contaminants; however, results showed that none of the eight dispersants displayed significant endocrine-disrupting activity via the androgen or estrogen signaling pathway. (For more information on EPA research to support emergency response efforts in the Gulf of Mexico, see *Crisis Science: All Hands on Deck*, on page 34 of this report.)

Human Health Risk Assessment

Human health risk assessment at EPA is focused on advancing the understanding of the effects that exposure to pollutants have on key biological, chemical and physical processes that affect human health.

Risk assessments by EPA scientists and their partners provide the foundation for the Agency's actions to protect public health and the environment. EPA's human health risk assessment efforts generate health assessments used to determine the potential risk to public health from exposures to environmental contaminants.

This section highlights some of the many accomplishments that EPA scientists and researchers made in 2010 to advance human health risk assessment, including: ushering in the "next generation" of risk assessment science, the release of an extensive database that provides both a powerful new resource to scientists and a new level of transparency to the public, final integrated science assessments for carbon monoxide and the National Ambient Air Quality Standards, and more.

Human Health Risk Assessment

A New Era for EPA's Integrated Risk Information System (IRIS)

The Agency advances the management of chemical risks.

Over its 40-year history, EPA has embraced the critical role of providing timely, high-quality, and accessible human health risk information on environmental contaminants, especially about contaminants that may endanger the American public. Today, a central aspect of that role is the Agency's Integrated Risk Information System (IRIS) program. IRIS is a human health assessment program that evaluates risk information on health effects that may result from exposures to environmental contaminants. Through the IRIS program, EPA provides the highest quality science-based human health assessments to support the Agency's regulatory activities to protect the public.

The IRIS database includes more than 540 chemical substances and contains crucial information on ways human health is impacted by exposure to those substances in air, water, and land from contaminated sites and from products. Combined with specific exposure information, government and private entities use IRIS to help characterize public health risks of chemical substances in a site-specific situation, thereby supporting risk management decisions designed to protect public health.

In 2010, EPA continued to implement a revamped and greatly improved IRIS process to ensure the scientific quality, integrity, transparency and timeliness of EPA's effort to manage chemical risks. The IRIS development process includes a streamlined review schedule, ensuring that the majority of assessments are posted on IRIS within 2 years of the assessment start date.

Ten final IRIS assessments were released in 2010, and significant progress was made on a number of draft assessments—exceeding the average productivity of the program over the last 3 years.

The 10 final IRIS assessments released in 2010 were:

- Chloroprene
- Cis-1,2-dichloroethlyene
- Pentachlorophenol
- 1,1,2,2-Tetrachloroethane
- Trans-1,2-dichloroethylene
- Hydrogen cyanide and cyanide salts
- 1,4-Dioxane
- Ethylene glycol monobutyl ether (EGBE)
- Carbon tetrachloride
- Acrylamide

For more information and to access the updated IRIS program, visit: www.epa.gov/iris/index.html.

HERO Streamlines EPA Science Assessments, Marks Milestone in Transparency

An Agency database provides open access to state-of-the-science information used for science assessments.

EPA took a major step in advancing open government and transparency when it announced the launch of the Health and Environmental Research Online (HERO) database in March 2010.

HERO is an open and accessible online database built from a wealth of scientific literature and information. EPA researchers designed the database to provide sophisticated search capabilities and elegant access, review, and analysis of the ever-growing body of scientific literature on which they rely. This includes peer-reviewed journals and literature, as well as technical bulletins, conference proceedings, and other sources that can provide the latest scientific findings as well as insight into emerging directions and trends, yet may be lost in less robust databases.

The database includes more than 300,000 scientific articles. For each reference, HERO contains:

- Reference type.
- Citation elements: author's name, title, year of publication, source. Depending on the type of reference, the citation also may include volume, page numbers, URL, etc.
- Abstract or brief description.
- Topic areas that describe the reference (e.g., carbon monoxide, asthma).
- Assessment(s) in which the reference was used, if relevant. Note that HERO contains references considered for use in assessment development, not just those references actually used.
- For "key" studies: objective, quantitative extracted study data.

HERO provides EPA researchers with a powerful tool to inform the development of risk assessments. The Agency uses risk assessments to integrate exposure and health or ecological effects information into a characterization of the potential for health hazards in humans or our environment. The process is highly interdisciplinary, drawing from such diverse fields as biology, toxicology, ecology, epidemiology, engineering, geology, statistics, and the social sciences to create a rational framework for evaluating environmental hazards.

HERO is an "evergreen" database, meaning it employs mechanisms to continuously incorporate new science publications. Added references are sorted, classified and made available through HERO. These efforts keep EPA scientists and others abreast of the rapidly growing body of scientific literature, and help them to meet their mission of assessing state-of-the-science findings to protect human health.

In addition to supporting Agency researchers, HERO provides the public with an easy way to search and analyze the scientific literature underlying risk assessments used to support EPA decision-making. The database's systematic, comprehensive search and screening techniques are transparent and open, and the HERO website incorporates opportunities and mechanisms to facilitate public and stakeholder participation in the identification of key research. As such, the release of HERO in 2010 marked a key milestone in EPA's open government directive to conduct business with transparency, participation, and collaboration.

For more information and to participate, visit the HERO Web site at: http://cfpub.epa.gov/ncea/hero/.

EPA Human Health Risk Assessments

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EPA released the following final Integrated Science Assessments in 2010:

- Integrated Science Assessment (ISA) for Carbon Monoxide (CO)

  On January 29, 2010, EPA announced the release of the final Integrated *Science Assessment (ISA) for Carbon Monoxide (CO)*. The report presented EPA's latest evaluation of the scientific literature on the potential human health and welfare effects associated with ambient exposures to CO.

  CO is one of six principal (or criteria) pollutants for which EPA must establish National Ambient Air Quality Standards (NAAQS) to protect public health, including for "sensitive" populations such as asthmatics, children, and the elderly. Periodically, EPA reviews the scientific basis for these standards by preparing an ISA. The ISA and supplementary annexes, in conjunction with additional technical and policy assessments, provide the scientific basis for EPA decisions on the adequacy of the current NAAQS and the appropriateness of possible alternative standards.

  Together with the final ISA for Particulate Matter (PM), which was released in late 2009, the completed CO assessment led to the posting of the revised and fully implemented NAAQS process.

- Perspectives on the Application of Mechanistic Information in Chemical Hazard and Dose-Response Assessments

  On September 29, 2010, EPA released a project summary called, *Perspectives on the Application of Mechanistic Information in Chemical Hazard and Dose-Response Assessments*. The summary lists several EPA articles reviewing approaches for applying mechanistic information in human health risk assessment and exploring opportunities for progress in this area.

  The report was the result of an EPA-initiated multidisciplinary project to critically review methods for applying mechanistic information in human health risk assessment and to explore strategies for progress in this area. The project examined approaches for interpreting observed effects in laboratory animals and their human relevance based on hypothesized modes of action. In addition, a critical aspect of the project was to explore issues pertinent to toxicity-pathway based risk assessment.

- Potential for Incorporation of Genetic Polymorphism Data in Human Health Risk Assessment

  On September 19, 2010, EPA released a project summary called, *Potential for Incorporation of Genetic Polymorphism Data in Human Health Risk Assessment*. The summary lists several EPA articles that evaluated the potential impact of genetic polymorphisms in 10 metabolizing enzymes on the variability in enzyme function across ethnically diverse populations.

  The work presented focuses on the contribution of genetic polymorphisms to the variability in host metabolism and defense mechanisms by evaluating polymorphisms in 10 enzyme systems, including three Phase I metabolic enzymes (CYP2E1, CYP2D6, PON1), four Phase II metabolic enzymes (SULTs, UGTs, GSTs, NATs), and three detoxification enzymes (ALDH2, EH, NQO1).

- An Exposure Assessment of Polybrominated Diphenyl Ethers (PBDEs)

  On May 24, 2010, EPA released the

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final report *An Exposure Assessment of Polybrominated Diphenyl Ethers (PBDEs)*. The report provides a comprehensive assessment of exposure to this class of persistent organic pollutants, often used as flame retardants, for people living in the United States. Individual chapters address: the production, use, and lifecycle of PBDEs; environmental fate; environmental levels; and human exposure.

- An Approach to Using Toxicogenomic Data in U.S. EPA Human Health Risk Assessments: A Dibutyl Phthalate Case Study

  On January 13, 2010, EPA announced the availability of a final report titled, *An Approach to Using Toxicogenomic Data in U.S. EPA Human Health Risk Assessments: A Dibutyl Phthalate Case Study*. The report features the application of genomic technologies (e.g., transcriptomics, genome sequence analysis) to study effects of environmental chemicals on human health and the environment.

  It describes an approach to evaluating toxicogenomic data for use in risk assessment and a case study of dibutyl phthalate (DBP). A multidisciplinary team of scientists developed the approach for utilizing genomic data in risk assessment and performed the DBP case study.

  The principles of the approach include examining the genomic and toxicity data sets together, defining a set of questions to direct the evaluation, and performing new analyses of genomic data when relevant. The report includes the development of exploratory methods and preliminary results from genomic data analyses. In addition, recommendations, research needs and future directions for applying genomic data to risk assessment were identified. The approach and case study may be used as a template for evaluating and analyzing genomic data in future chemical assessments as well as by researchers performing genomic studies for use in risk assessment.

Draft Scientific Report on Dioxin Toxicity Released

EPA released a draft scientific report, *EPA's Reanalysis of Key Issues Related to Dioxin Toxicity and Response to NAS Comments* for independent external review and public review and comment.

The public release of the draft scientific report marked a significant milestone toward the completion of the Agency's dioxin reassessment. It provides EPA's response to the key recommendations and comments included in the National Academy of Sciences (NAS) 2006 report. In addition, the report includes new analyses on potential human effects that may result from exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

This comprehensive human health and exposure risk assessment on dioxin, one of the most toxic environmental contaminants, aims to protect the health of the American public.

Health Science Information on Formaldehyde and Trichloroethylene (TCE) Toxicity

EPA completed a comprehensive examination of the health science information on formaldehyde and trichloroethylene (TCE) toxicity and released external review drafts for public comment. Formaldehyde is important both to public health and to a number of upcoming residual risk rulemakings under the Clean Air Act. TCE is one of the

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most common pollutants of concern at Superfund sites in the United States and also can be found in drinking water and air emissions.

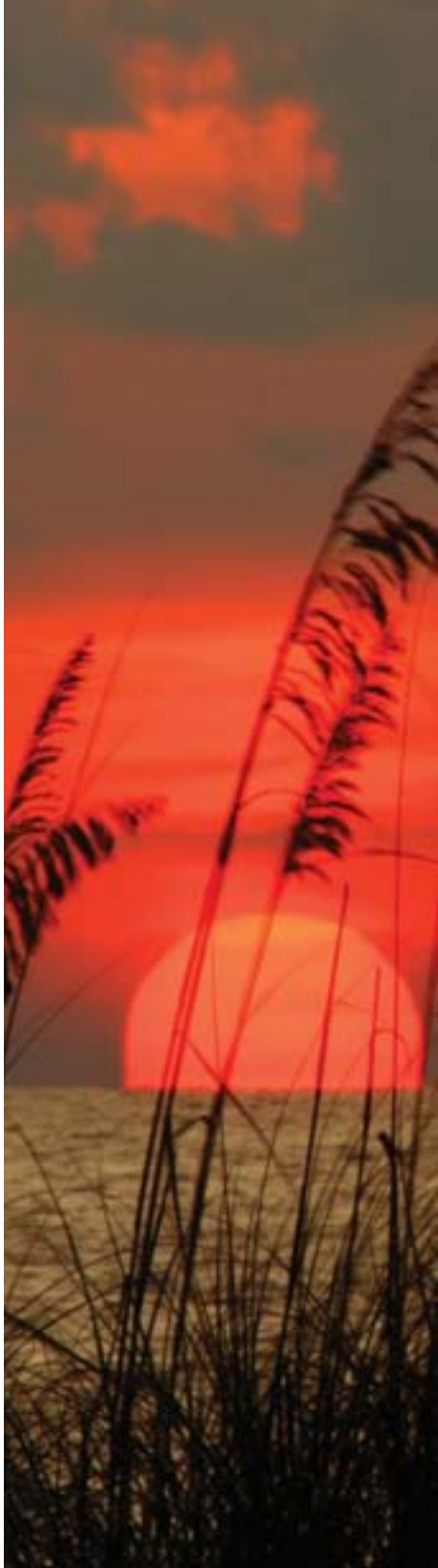
Innovative Modeling Tools Help EPA Scientists Determine Total Chemical Exposures

Using sophisticated new computer models and methods, EPA scientists developed an innovative set of tools to estimate total exposures and risks people face from chemicals encountered in everyday activities, actions as simple as biting into an apple or walking across a carpet.

The development of these new tools involved linking two types of models the Stochastic Human Exposure and Dose Simulation (SHEDS) model and physiologically- based pharmacokinetic (PBPK) models. The SHEDS model can estimate the range of total chemical exposures in a population from different exposure pathways (such as inhalation) over different time periods, given a set of demographic characteristics. PBPK models predict how chemicals move through and concentrate in the human body.

Combining these models, EPA researchers created a first-of-its-kind set of tools that scientists can employ to estimate the total exposures and resultant doses that humans experience from chemicals in their environments.

The tools represent a breakthrough in risk management. Now, instead of examining a single route of exposure, scientists can look at the comprehensive exposure "picture" in a given population, which will prove helpful as EPA studies the risks posed by chemicals such as pyrethroid-based pesticides. These models will serve as invaluable tools in supporting decisions and actions to protect human health and the environment from the risk of exposure to harmful chemicals.



How does the U.S. Environmental Protection Agency meet its mission to safeguard human health and protect the environment?

It all starts with science.

EPA's Office of Research and Development (ORD)—the science arm of the Agency—is forging a path forward toward a sustainable future. ORD research is conducted under the following integrated research areas.

Air, Climate, and Energy

American communities face serious health and environmental challenges from air pollution and the growing effects of climate change, both of which are intricately linked with energy options.

Building on 40 years of achievement in air pollution research that has led to landmark outcomes—including healthier communities and longer life expectancies—EPA researchers are exploring the dynamics of air quality, global climate change and energy as a set of complex, yet interrelated challenges.

Safe and Sustainable Water Resources

Seeking sustainable solutions to the complex problems facing our nation's drinking water and water resources is vital to supporting healthy humans, ecosystems and economies.

EPA's safe and sustainable water resources research provides the science and innovative technologies the Agency—and the Nation—need to maintain drinking water sources and systems, as well as to protect the chemical, physical and biological integrity of our water. EPA scientists and engineers help provide sustainable water infrastructure, deliver safe drinking water, manage stormwater, and remove and treat wastewater, allowing its sustainable and safe reuse.

Sustainable and Healthy Communities

How can we meet today's needs without compromising those of future generations? More specifically, how can people protect our shared environment in a way that fosters human health and well-being, is socially just, and promotes economic prosperity?

Providing the science to answer the questions posed above is at the heart of EPA's sustainable and healthy communities research. Agency researchers and their partners from across a wide spectrum of investigative fields are working together to form a deeper understanding of the balance between the three pillars of sustainability—environment, society and economy. Their transdisciplinary work will provide the decision tools and data that communities need to make proactive, strategic decisions aimed at a prosperous, more environmentally sustainable future.

Sustainability: the *True North* of EPA Research

Providing elegant, innovative solutions that help society meet its own needs while preserving the ability of future generations to meet their own—sustainability—is the *True North* of EPA research.

EPA's Integrated Transdisciplinary Research approach transcends traditional scientific boundaries, bringing together researchers and users of research in search of sustainable solutions to today's most pressing environmental and related human health challenges.






Chemical Safety for Sustainability

Chemical safety is a major priority of EPA and its research. Moving toward a safer and more sustainable environment requires producing new and existing chemicals in safer ways. It means having the information and methods needed to make better informed, more timely decisions about chemicals. The challenges are formidable: tens of thousands of chemicals currently are in use and hundreds more are introduced every year. Many of these chemicals have not been thoroughly evaluated for potential risks to human health and the environment. In addition, the consequences of use over a chemical's life cycle (from production to disposal) are not thoroughly evaluated. EPA research on chemical safety is geared to meet this challenge.

Using innovative approaches, EPA scientists and their partners are embracing the principles of green chemistry to produce safer chemicals. They also are integrating a diversity of scientific disciplines to develop new prediction techniques, pioneering the use of innovative technologies for chemical toxicity testing and designing tools to advance the management of chemical risks. Chemical Safety for Sustainability includes research in computational toxicology, nanotechnology, endocrine disrupting chemicals, human health, and pesticides.

Human Health Risk Assessment

Human health risk assessment at EPA is focused on advancing the understanding of the effects that exposure to pollutants have on key biological, chemical, and physical processes that affect human health.

What EPA scientists and their partners learn provides the foundation for the Agency's actions to protect public health and the environment. EPA's human health risk assessment efforts generate health assessments that are used to determine the potential risk to public health from exposure to environmental contaminants.

Homeland Security

Following the terrorist attacks of September 11, 2001, EPA was directed to tap its collective scientific and technical expertise to help protect human health and the environment from the effects of terrorist incidents. EPA was charged with helping to decontaminate buildings and large public areas, protect our nation's water supply, and rapidly provide reliable information to key decision- makers, stakeholders and impacted communities on analytical methods and human health risks.

EPA's Homeland Security Research Program supports the Agency's leadership role in remediating chemical, biological, or radiological (CBR) contamination from weapons of mass destruction. The program also conducts research on drinking water and wastewater systems as the Agency is the federal sector lead for water infrastructure. Many of EPA's homeland security research products and technologies have broader environmental and health protection applications.

Homeland Security

Following the terrorist attacks of September 11, 2001, EPA was directed to tap its collective scientific and technical expertise to help protect human health and the environment from the effects of terrorist incidents involving chemical, biological, and radiological (CBR) contamination. EPA was charged with helping to decontaminate buildings and large public areas, protect our Nation's water supply, and rapidly provide reliable information to key decision- makers, stakeholders and impacted communities on analytical methods and human health risks. EPA's homeland security research helps provide the science and technology that directly supports the Agency's leadership role in remediating CBR contamination, homeland security attacks, or accidental releases. The program also conducts research on drinking water and wastewater systems, as the Agency is the sector lead for water infrastructure. Many of EPA's homeland security research products and technologies have broader environmental and health protection applications.

This section highlights some of the many accomplishments that EPA scientists and engineers made during 2010 to advance homeland security research, including: testing the effectiveness of various decontamination technologies during the recovery phase after a terrorist event involving radiological contamination, receiving a prestigious *R&D 100 Award* for threat-detection software developed to help protect the Nation's drinking water supplies, developing performance specifications for materials to mitigate the spread of radioactive contamination following a dirty bomb explosion, and more.

EPA Leads National Exercise for Response and Recovery from "Dirty Bomb" Scenario

Agency scientists provided key support for the Liberty RadEx exercise—a major simulation of testing, cleanup, and recovery phases following a deliberate radiation attack.

In 2010, EPA emergency response managers from Regions 3, 4, and 5 led an extensive training exercise to prepare for responding to and recovering from a terrorist attack in an urban setting involving the detonation of a "dirty bomb" containing radiological materials.

The *Liberty RadEx Exercise* (LRE) was a National Tier 2 Full-Scale Exercise sponsored by EPA and co-sponsored by the Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection and the City of Philadelphia Office of Emergency Management. Over 1000 individuals participated in LRE representing, 35 federal, state, and local agencies; nine community groups; 14 private businesses; two universities; and scientists and observers from six foreign countries. They were involved in both field drills and training exercises held from April 27 to 29 in and around Philadelphia, Pennsylvania.

Most exercises to date have focused on crisis response during the immediate aftermath of a terrorist attack. EPA researchers supported Region 3 in the planning and design of *LRE* as an exercise for developing and practicing the critical remediation and recovery actions that are needed in the weeks and months after the initial lifesaving phase of a response covering a large population and geographic area.

The scenario in *LRE* was built around the potential aftermath of a suicide attack, launched from a van, loaded with 3,000 pounds of ammonium nitrate mixed with diesel fuel and radioactive Cesium-137. EPA researchers participated in multiagency planning workgroups and provided expertise and technical support to help define the critical, long-term issues that would have to be addressed following such an explosion. They ensured that the latest research and technology were available to all participants in the exercise.

During *LRE*, EPA scientists and engineers also served as "controllers" or "evaluators." Controllers challenged participants by adding complexities known as "injects" (such as sudden changes in the incident or the discovery of new information) to practice simulations and exercises. Evaluators determined whether all activities were performed successfully and in accordance with plans, policies, procedures, and agreements.

The drill also provided a real-world opportunity to apply, demonstrate clean-up technologies in the field that had previously been tested in research laboratories. For example, during the drill, participants were able to apply strippable coatings for radioactively contaminated surfaces, in a subway station and a decontamination foam at the Philadelphia Fire Department Training Academy's building.

EPA researchers and their partners used *LRE* events to further develop and test a new tool that integrates contaminant plume maps with Geographic Information System data. This tool estimates the quantities and activity levels of contaminated waste and debris, including building debris and outdoor materials such as asphalt and soil. Officials in charge of cleanup decisions applied these estimates to evaluate trade-offs between decontamination and disposal options.

EPA researchers also learned valuable lessons about their role in the response to a large incident as part of the overall EPA response community, providing technical support to the exercise players as they would provide technical support to the

EPA Leads National Exercise for Response and Recovery from "Dirty Bomb" Scenario, *Cont'd.*

incident command in a real event. Lessons learned from *LRE* help to inform how all levels of government, business, and community organizations can work together to meet the challenges associated with long-term cleanup and community recovery following a dirty bomb attack.

EPA Researchers and Partners Win *R&D 100 Award* for CANARY

Award-winning software helps Nation protect drinking water supplies.

EPA researchers and their collaborators from the Department of Energy were recognized with a 2010 "*R&D 100 Award*" from *R&D Magazine* for CANARY—software they developed to improve the security of drinking water systems. The software, in conjunction with a network of sensors, can rapidly detect contamination, providing critical information to support decisions and actions taken to protect human health from tainted drinking water.

R&D 100 Awards are given annually to the 100 most technologically significant products introduced in the past year. CANARY software is being piloted in five U.S. cities (Cincinnati, New York, Los Angeles, Philadelphia and San Francisco) and Singapore using data sets that are unique to each system. Based on data analysis performed by CANARY, the pilot utilities can better detect when they need to alert their customers to a hazardous level of contamination in their drinking water supply. This in turn enables them to incorporate new guidelines into their emergency response and consequence management plans.

CANARY software evaluates standard water quality data such as free chlorine, pH and total organic carbon over time, and uses mathematical and statistical techniques to identify the onset of anomalous water quality incidents. Before using CANARY for the first time, historical utility data must be used to determine the natural variation of these water quality parameters. This allows the water utility to adapt CANARY to work accurately at multiple locations within the water distribution system and helps utility operators to understand any expected false alarm rates associated with CANARY and contamination incident detection.

The CANARY software allows for:

- The use of a standard data format for input and output of water quality and operations data;
- The ability to select different detection algorithms (CANARY contains three different mathematical approaches for analyzing the data);
- The ability to select various water utility and location-specific configuration options;
- An online operations mode and an offline evaluation mode;
- The ability to generate data needed to establish performance metrics (e.g., false alarm rates).

CANARY assists water utilities in understanding the significance of large volumes of water quality data. It can automatically review incoming data regarding anomalous conditions and

EPA Researchers and Partners Win *R&D 100 Award* for CANARY, *Cont'd.*

alert the water utility if further action is required. Not only can CANARY detect anomalous conditions resulting from contamination incidents, but it also can detect unexpected "normal" events, such as a sensor malfunction or a pipe break.

The CANARY software is not intended to replace commercially available software but to supplement existing software and motivate commercial development of similar products. It is hoped that the release of CANARY also will lead to additional research and development in this field.

As a free software tool, CANARY is available worldwide to drinking water utilities striving to provide safe water to their customers. To date, more than 600 users in 15 countries have accessed the software.

Rapid Detection Methods Help Speed Recovery From Radiological Contamination

EPA researchers developed new methods to expedite analysis of water samples.

In 2010, EPA published a compendium of methods for rapidly detecting selected radionuclides in drinking and surface water. The methods were developed for laboratories that would support EPA's response and recovery actions following a radiological or nuclear incident such as the detonation of an improvised nuclear device or a radiological dispersal device ("dirty bomb").

EPA homeland security researchers collaborated with the Agency's Office of Radiation and Indoor Air to develop the rapid analytical methods. The new methods reduce the sample processing time from days or weeks to just 8 to 38 hours.

Methods were developed for five radionuclides that could be used in a radiological dispersion incident and are difficult to detect in the field using hand-held instruments. They are: americium-241, plutonium-238 and plutonium-239/240, isotopic uranium, radiostrontium (strontium-90), and radium-226.

In addition to expedited analysis, EPA researchers developed the new methods to provide quantitative results that meet measurement quality objectives for the intermediate and recovery phases of a nuclear or radiological incident.

Laboratories can now get results back to the field more quickly, helping responders and decision-makers develop cleanup strategies. In addition, after cleanup has been completed, the new methods provide data that can be used for determining when the site is safe again for public use.

The new methods will be added to EPA's "Selected Analytical Methods (SAM) for Environmental Remediation and Recovery" in the fall of 2011.

For more information, please visit: http://www.epa.gov/nhsrc/news/news081910.html.

Performance Specifications for Materials for Mitigating Radioactive Contamination

EPA researchers develop performance specifications for coatings and other products that can be applied.

After a dirty bomb (a radiological dispersal device) has been detonated, wind, weather and both vehicle and pedestrian traffic can increase the spread of contamination. As contaminants migrate and bind to nearby surfaces, they can become more difficult to decontaminate.

Working in collaboration with the American Society for Testing and Materials, (ASTM) International Subcommittee E54.03 on Decontamination, EPA researchers developed performance specifications (ASTM E2731) for materials available to mitigate the spread of radioactive contamination following a dirty bomb detonation. The materials—"coatings and other products"—can be applied to exterior surfaces in an urban environment to mitigate the spread and binding behavior of radiological contamination.

Adequate preparation and development of effective mitigation and decontamination technologies will ensure the most rapid and effective recovery from a radiological event, as well as provide a measure of deterrence. Products described in the ASTM Standard would be principally used by federal, state and local government emergency responders and response planners, decontamination service providers and those interested in protecting and recovering from radiological terrorism.

Provisional Advisory Levels for Interim Recovery Actions

EPA researchers advanced the development of health-based advisory levels for high-priority hazardous chemicals and warfare agents.

During 2010, EPA researchers advanced the development of health-based provisional advisory levels (PALs) for high-priority hazardous chemicals and chemical warfare agents in ambient air and drinking water. To date, EPA has developed PALs for more than 100 priority chemical agents. A total of about 1,800 acute, short- and long-term values have been derived for potential ingestion and inhalation exposures.

The development and application of PALs will facilitate effective risk management and risk communication decisions to minimize the adverse impact of threat agents to the general public. PALs also will be used for emergency exposure planning at federal, state and local levels.

Building Partnerships, Serving Regions, and Supporting Communities

EPA supports the Nation's leading scientists and engineers to facilitate the pursuit and dissemination of high-quality research to build a strong scientific foundation for Agency actions and decisions. In addition, EPA researchers cultivate and maintain partnerships with research colleagues at colleges and universities across the world, at sister federal and state agencies, and other entities throughout the scientific community.

The Agency's extramural research program funds research grants, graduate and undergraduate fellowships and large research centers through a competitive solicitation process and independent peer review. These programs engage the Nation's best scientists and engineers in targeted research that complements EPA's own outstanding intramural research programs.

EPA is also one of 11 federal agencies that participate in the Small Business Innovation Research (SBIR) program, enacted in 1982 to strengthen the role of small business in federal research and development, create jobs, and promote technical innovation. EPA's SBIR program awards funds to innovative small businesses that have novel concepts for products and technologies that will help spur economic growth while advancing a more sustainable future.

EPA scientists partner directly with Agency regional offices to bring the collective expertise of Agency scientists and engineers to bear on high-profile environmental and related human health challenges.

This section highlights some of the many accomplishments that EPA made in 2010, such as building partnerships and supporting EPA regions and communities, including: inspiring the next generation of environmental engineers and scientists through the 6th Annual Student Design Competition for Sustainability, the 2010 EPA Tribal Science Forum, and a number of grants and awards that are helping to stimulate a vibrant and sustainable economic recovery and advance the Nation's commitment to science and technology leadership.

When Students Compete for Sustainability, Everybody Wins!

Student engineers and scientists competed for the Best Sustainable Design at the Annual National Sustainable Design Expo.

On April 24 and 25, 2010, 42 teams of budding scientists and engineers from colleges and graduate schools from across the country gathered on the National Mall in Washington, DC, at the Sixth Annual National Sustainable Design Expo to showcase their innovative designs for advancing environmental sustainability.

The teams competed for the U.S. Environmental Protection Agency's coveted P3 Award for sustainability.

The three "P's" in P3 stand for People, Prosperity and the Planet. Established in 2004, the competition is focused on supporting innovative designs that benefit people, promote prosperity and protect the planet while advancing sustainability in both the developed and developing world.

The competition has two phases. In phase I, student teams and their faculty advisors submit research proposals for a chance to earn up to $10,000 in seed money to research and develop their design projects during the academic year.

All phase I grantees are invited to the National Mall in Washington, DC, each spring to present their projects at the National Sustainable Design Expo. Each design is reviewed by a panel of judges convened by the American Association for the Advancement of Science (AAAS). The panel's evaluations are passed on to EPA officials, who then award the prestigious EPA P3 Award.

The P3 Award brings with it the opportunity to receive up to $75,000 in additional funding to advance designs from the prototype phase to the marketplace.

The winning 2010 P3 teams and their innovative sustainable designs were:

- Appalachian State University
  Biomass Gasification for Agricultural Energy Sources and Soil Enrichment
- Clarkson University
  Farm Waste to Energy: A Sustainable Solution for Small-Scale Farms
- Clarkson University
  Sustainable Year-Round Food Production in Cold Climates
- Clemson University
  SEED: Emergent Container Housing Initiative—Solutions for the Caribbean
- Cornell University
  Dose Controller for AguaClara Water Treatment Plants
- Drexel University
  Alkali-Activated Slag Cement (AASC) as a Sustainable Building Material
- Humboldt State University
  Smoothing the Peaks: Smart Outlets to Reduce Brownouts on Micro-Hydroelectric Mini-Grids in Bhutan

When Students Compete for Sustainability, Everybody Wins! *Cont'd.*

- North Carolina Agricultural and Technical State University
  Enhancing Urban Sustainability Through the Application of Permaculture Principles
- Roger Williams University
  Development of Alternative Power to Drive a Partitioned Aquaculture System for Intensive Food Fish Production
- Texas A&M University
  Horizontal Hybrid Solar Light Pipe: An Integrated System of Daylight and Electric Light
- University of Illinois at Urbana-Champaign
  Virus Removal in Slow-Sand Filters for Rural Mayan Communities
- University of North Carolina at Chapel Hill
  Evaluation of Chitosan Coagulation as a Sustainable Method for Point of Use Drinking Water Treatment in Developing Countries
- Virginia Polytechnic Institute and State University (Virginia Tech)
  A Sustainable Approach to Nitrate Reduction Combining a Riparian Zone With a Stream Denitrifying Biofilm
- Wellesley College, Harvard University, Massachusetts Institute of Technology, and Qinghai Normal University
  A Comprehensive Platform for Rural Energy Optimization in the Himalayan Region

The announcement of the winning teams was not the only highlight of the year for EPA's P3 Award Competition. Micromidas, a small business founded by former P3 winning students that now employs 26 people, was selected as one of the Top 50 Water Innovation Leaders by the Artemis Project. In addition, 2010 was the first full year of educational service for The Learning Barge, a floating field station and classroom designed by a 2007 P3 team from the University of Virginia that created seven new green jobs.

EPA Co-hosted the 2010 National Tribal Science Forum

Mother Earth: Indigenous Knowledge and Science to Promote Positive Change.

The National EPA-Tribal Science Council co-hosted its second National Tribal Science Forum in partnership with the Grand Traverse Band of Ottawa and Chippewa Indians. The 2010 National Tribal Science Forum took place June 6-10, 2010, at the Grand Traverse Resort and Spa, owned by the tribe and located near the tribal complex in Traverse City, Michigan. The forum theme was *Mother Earth: Indigenous Knowledge and Science to Promote Positive Change*.

More than 225 attendees representing more than 60 American Indian tribes and Alaska Native villages; tribal colleges and universities; tribal organizations; intertribal consortia; private and nonprofit organizations; federal, state, and local governments—as well as representatives of EPA and other federal agencies—participated in the 5-day event.

The Forum was structured around the concept of the Circle of Life, or Medicine Wheel, a powerful symbol that has many meanings to the First Nations and American Indian tribes across America. Four knowledge tracks—Air, Water, Earth, and Community Health—aligned to four directions of the Circle provided the basic concepts around which participants shared Western and traditional tribal knowledge. Climate change was an overarching theme among the knowledge tracks.

The purpose of the Forum was to provide platforms to discuss issues of vital interest to Indian Country. The Forum:

- Showcased tribal science through cutting-edge research and case studies.
- Promoted native science and highlighted progress being made in environmental and health programs on tribal lands.
- Highlighted tribal science success stories through presentations, exhibits and a poster session.
- Provided opportunities for technical training in high-priority areas identified by tribal governments and Tribal Science Council members.
- Facilitated networking and the sharing of knowledge among native scientists and environmental professionals from throughout Indian Country.
- Linked scientists and other attendees with Native American students so they could talk, listen, and "hear their environmental voices."
- The range of activities at the Forum included scientific presentations, intensive professional trainings, poster presentations, a local field trip, a film screening and networking sessions.

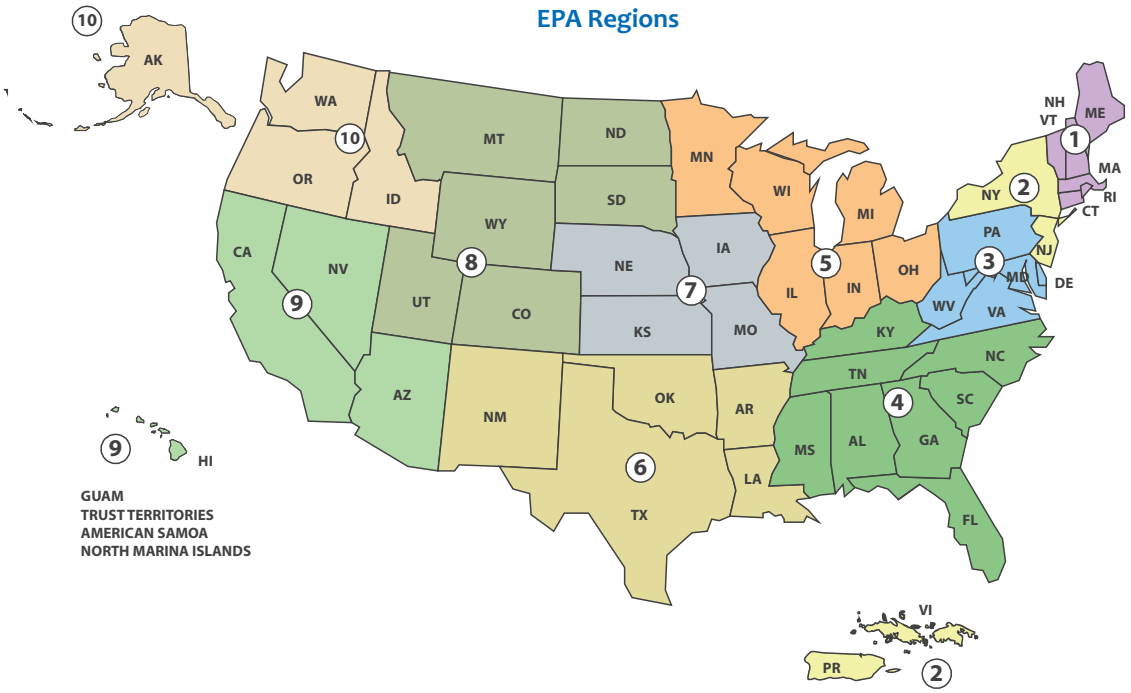
Partnerships: Serving the Regions and Tribes

Bringing science and expertise to meet high-priority local science needs.

EPA has ten regional offices across the country, each of which is responsible for meeting the Agency's mission to protect human health and the environment in the states and territories within its region. To support those efforts, Agency scientists and engineers form partnerships with their colleagues in the states and territories to effectively respond to the high-priority, near-term research needs of regional offices.

Annually, the Agency makes funds available to each EPA region to develop research topics, and working partnerships are established to coordinate all necessary interactions between regions and scientists and other technical staff across the Agency. Such partnerships: (1) provide the regions and communities across the Nation with near-term research on high-priority localized needs; (2) improve collaboration between regions and Agency laboratories and research centers; (3) build the foundation for ongoing and future scientific interactions; and (4) develop useful tools for state, local and tribal governments to address near-term and emerging environmental challenges.

EPA Regions



Highlights From 2010 EPA Regional Science Partnerships

Region 1 (New England)

- Agency researchers continued to evaluate the unique cultural exposure pathways of the Penobscot tribe in Maine to assess potential public health threats of ongoing traditional practices, such as gathering medicinal plants, fishing, and harvesting wild duck and turtle meat. The contaminant exposure assessments resulting from the study are expected to inform tribal, federal, state and local decision-makers in restoring a healthy, functioning ecosystem to further strengthen the environmental, economic and social integrity of the Penobscot Nation.

- EPA researchers are partnering with colleagues from the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (USFWS), and numerous states and municipalities to address the issue of pharmaceuticals in low flow situations on the Assabet River. What is learned from this study has the potential to set a precedent for future federal discharge permits in the state.

Region 2 (New Jersey, New York, Puerto Rico, the U.S. Virgin Islands and eight Tribal Nations)

- New York City Department of Health's recent Health and Nutrition Examination Survey found that the geometric mean of blood mercury concentrations in the 1,811 adult New Yorkers tested were three-times that of the national estimate. In response to that alarming finding, Region 2 and Agency scientists measured mercury and PCBs in the 20 most commonly consumed fish and shellfish products sold in New York City's New Fulton Fish Market, the Nation's largest wholesale fish market.

  Results from the collaborative study were used to support and inform the content of New York City's "Eat Fish, Choose Wisely" public health campaign on dietary guidelines for the City's 8 million residents.

Region 3 (Mid-Atlantic)

- Since 2006, EPA scientists have provided scientific support for enhanced review of 79 mountaintop valley fill permit applications based on the potential impacts of total dissolved solids on aquatic species. The permit decisions supported by the research results, including monitoring and mitigation technology options, will have a major environmental impact on the Appalachian region.

Region 4 (Southeast)

- EPA's Region 4 partnered to sponsor the *EPA Regional Science Workshop on Using Treated Graywater as an Environmental Solution* in Atlanta on May 18-20, 2010.

  The workshop brought together experts from EPA, the Centers for Disease Control and Prevention, other federal and state agencies, academia and the private sector to discuss and understand available science, and determine what additional science is needed to inform the Agency's research agenda and, ultimately, policy direction related to graywater.

  The workshop resulted in a consensus to pursue three primary research areas: (1) research

Highlights from 2010 EPA Regional Science Partnerships, *Cont'd.*

to support the development of metrics and tools that are needed to undertake urban water sustainability assessments; (2) research to provide better measures/indicators of graywater treatment performance, human/environmental impact and ways to cost-effectively achieve safe reuse; and (3) research to enable sociological, economic and regulatory reforms.

Region 6 (South Central)

- EPA researchers provided key support during emergency response activities after the Deepwater Horizon Oil Spill in the Gulf of Mexico.

Region 7 (Midwest)

- Region 7 and Agency scientists collaborated and coordinated in the monitoring, assessment and mitigation of unknown CO_2 intrusions in homes located north of Wichita, Kansas. Region 7 worked with Agency scientists and the local community to help notify homeowners of the potential critical health effects caused by oxygen depletion and is carrying out a continuous monitoring effort to assist with understanding the potential sources and causes of CO_2 intrusions.

- Region 7 Superfund Remedial Project Managers (RPMs) found that groundwater samples collected at remediation sites contained binary mixtures of both the chemical oxidants used for *in situ* treatment and the contaminants being treated. These binary mixtures fouled laboratory equipment, had to be diluted to the point that data were often unusable, and the concentrations of the contaminants were not representative of site conditions.

  Agency scientists and other staff collaborated on a research project to test potential permanganate neutralization methods. As a result of the collaboration, a safe, novel preservative (ascorbic acid) was identified that effectively neutralized oxidants in samples.

  More than 3,000 sites using or considering permanganate as a remediation technology will benefit from this research by informing better short- and long-term groundwater remediation. The research results will directly benefit residential and community groundwater supply resource protection near hazardous waste sites.

- Historical mining, milling, and smelting activities have impacted residential properties and communities with contamination. Multiple collaborative applied research projects between Agency researchers and Region 7 are addressing issues, including a multistate, one-watershed cleanup plan for: a 2,500-square-mile area; a county-wide point-of-use drinking water system effectiveness evaluation; a city-wide surface and near-surface residential soil exposure study; a city-wide educational and social outcomes study; and a site-wide soil stockpile leaching study.

  The results of these activities will assist in reducing exposure to contaminants and better protecting residents and

Highlights From 2010 EPA Regional Science Partnerships, *Cont'd.*

communities. Both urban and rural residents and communities will benefit from increased effectiveness and efficiencies of remedies addressing historical mining, milling and smelting contamination.

Region 8 (Mountains and Plains)

- In Libby, Montana, Region 8 staff members have teamed up with Agency researchers to perform Libby amphibole-specific human health assessments to support several site-specific baseline assessments for risk. Agency technical staff performed analytical studies to support *in vitro* and *in vivo* toxicity studies and laboratory *in vitro* and *in vivo* studies. A Region 8 toxicologist developed a dosimetry model for improved exposure-response evaluations from Libby amphibole- exposed populations.

  Region 8 and Agency researchers are addressing specifically children's risk, collecting exposure data that include exposure scenarios targeted to children's activities, as well as conducting laboratory experiments with young rats exposed to Libby amphibole material.

- Region 8 and Agency scientists initiated a research project to study the green roof on the Agency's Regional Headquarters building. The research evaluated green roof technology for biological performance and its effectiveness as a best management practice for stormwater control and to mitigate the heat island effect in the region.

  In addition to providing air and water quality benefits and reducing heating and cooling needs, the green roof is expected to reduce peak flow and runoff volumes from rain and snowmelt events to mimic a more natural landscape. This will minimize harmful impacts from concentrated stormwater runoff to the nearby South Platte River.

  Green roof data collected will be added to the list of best management practices to help mitigate the environmental impacts of stormwater runoff from developed and developing areas and improving the health of the Nation's impaired waterways.

Region 9 (Pacific Southwest)

- EPA scientists worked with partners in Region 9 and the U.S. Geologic Survey (USGA) to publish a standard operating procedure (SOP) (*Collection of Pyrethoids in Water and Sediment Matrices: Development and Validation of a Standard Operating Procedure*) that could be followed to collect field samples in order to accurately monitor pyrethoid chemicals in the water.

  Pyrethroids are the most common insecticides used in agricultural areas and the urban marketplace. Because they are highly toxic to aquatic organisms, it is important that they be accurately measured in the environment. This can be a challenge because pyrethroid insecticides stick to the surfaces of collection containers, leading to inaccurate field samples that then confound analytical and toxicity test results. Working together, the research team provided standardized sample collection protocols for accurate pyrethroid

Highlights From 2010 EPA Regional Science Partnerships, *Cont'd.*

assessments, and results were used to prepare a USGS Scientific Investigations Report that included the Standard Operating Procedures for pyrethroid sampling.

Region 10 (Pacific Northwest)

- Agency researchers are conducting a study to evaluate the fate and effects of leachate contamination in Alaska's tribal drinking water sources, which helps characterize pathogens and toxins within Alaska's 200-plus tribal open dumps. Alaska's open dumps contain mixed solid and hazardous wastes and are underlain by permafrost, which may act as a liner or seal. This project will help develop and implement best management practices that can be used to improve the environmental conditions.
- Rural residents in Washington State's Yakima Valley, including the Yakama Tribe and a large population of migrant/seasonal farm workers, are using drinking water from private wells that exceed the Federal Safe Drinking Water Maximum Contaminant Level for nitrate. Some wells also exceed health-based benchmarks for pesticides, metals, and bacterial contamination.

  Region 10 and Agency scientists partnered with colleagues from the U.S. Geological Survey, the U.S. Department of Agriculture, the Indian Health Service, and state agencies as well as the local health district to address the issue. The approach they are using includes conducting area-wide sampling to outline the extent of the contamination, identify agricultural or other contaminant sources, and support mitigation actions.

  Results so far have included the development of a unique GIS mapping method to target sample collection for identifying source contributions in agricultural settings. The partnership effort will further determine measures to protect public health and may contribute to voluntary changes and, if necessary, support for EPA enforcement actions.

Stoking the Nation's Economic Engine: EPA's Small Business Innovation Research Awards

Agency awards spur economic growth while supporting green investments.

There are approximately 25 million small businesses in the United States today. As the leading source of employment growth, these firms have generated 60 to 80 percent of net new jobs over the past decade and are responsible for developing most of the country's new technologies.

Today, EPA is helping to tap the economic engine and creative energy of small businesses to help meet environmental challenges while they help lead an economic recovery.

In 2010, EPA awarded 4.855 million to 45 small businesses to develop innovative, sustainable technologies to protect human health and the environment. These efforts will help improve air quality, protect water, work to decrease the effects of climate change, and support green jobs.

The award-winning businesses, located in 16 different states, focused on several key environmental research areas: increasing the efficiency of green building materials and systems; manufacturing innovation; prevention, monitoring and control using nanotechnology; reducing greenhouse gases; new treatment technologies for drinking water; improving water infrastructure; reducing emissions from small air pollution sources, vehicles and biofuels production facilities; new approaches for cleaning up and monitoring hazardous waste sites; and new tools for homeland security systems.

EPA's SBIR program was established to ensure that new technologies are developed to solve priority environmental problems. EPA is one of 11 federal agencies that participate in the SBIR program, enacted in 1982 to strengthen the role of small businesses in federal research and development, create jobs and promote technical innovation in the United States.

In 2010, Ecovative Design, a previous EPA-supported SBIR winner, was selected as a Technology Pioneer by the World Economic Forum (WEF). The award recognized the development of a patent-pending material platform that uses crop wastes as the raw material to produce a strong and fast-growing resin that is an alternative to expanded polystyrene (EPS) used in the multibillion dollar protective packaging market.

Ecovative leveraged more than $6 million in venture capital funds as a result of its EPA SBIR award, and has created more than 20 new green jobs.

Building Partnerships, Serving Regions, and Supporting Communities

Recipient	Title	$ Awarded
AccuStrata, Inc.	Development of Intelligent Process Control for Thin Film Solar Panel Manufacturing	$70,000
AdvR, Inc.	Fiber Based Return Signal CO_2 Sensing System for Sequestration Site Monitoring	$69,984
Aerodyne Research Inc.	PM 2.5 Emissions Reduction for Two-Stroke Engines	$70,000
Air Quality Design, Inc.	Combined Gas and Particle Measurement System	$69,676
AlburtyLab, Inc.	A Hydrosol Concentrator for Improved Measurement of Microbial Pathogens in Drinking Water	$69,972
AquaBioChip, LLC	Inexpensive, Rapid and Comprehensive Virulence and Marker Gene (VMG) Analyzer for Waterborne Pathogens	$70,000
Aspen Products Group, Inc.	Reduction of Hazardous Air Pollutant Emissions from Commercial Kitchens	$70,000
Cbana Labs, Inc.	Nanoporous Metal Organic Framework Filters for Removal of Gaseous Pollutants	$70,000
Coating Systems Laboratories, Inc.	Antimicrobial-Coated Granular Filter Media for Drinking Water Treatment	$70,000
Light Curable Coatings	Pigmented Solvent-Free Corrosion-Resistant UV Coating System	$69,997
Defiant Technologies, Inc.	Handheld Detection System for TCE and PCE	$70,000
Eltron Research Inc.	Low-Cost Retrofit Emissions Control in Off-Road Sources	$69,999
Enchem Engineering, Inc.	Advanced Mixed Oxidation and Inclusion Technology	$70,000
Excellims Corporation	Compact High Resolution Electrospray Ionization Ion Mobility Spectrometer for Online Water Monitoring	$70,000
Filtrexx International, LLC	Performance and Design Development for Compost Technology Used in Green Infrastructure, Green Building, and Urban Storm Water Applications	$68,510
Fusion Coolant Systems, Inc.	Through-Tool Drilling with Supercritical CO_2 Metal Working Fluids	$70,000
Instrumental Polymer Technologies, LLC	Silane-Terminated Aliphatic Polycarbonate Dendrimer Solutions for Environmentally Green Coatings	$70,000
IntAct Laboratories, LLC	Bio-Electrochemical Systems for Ethanol Wastewater Treatment	$46,770

Building Partnerships, Serving Regions, and Supporting Communities

Recipient	Title	$ Awarded
Intelligent Optical Systems Inc.	Distributed Optical Fiber Sensor for Long-term Monitoring of Groundwater Trichloroethylene Levels	$70,000
IntelliMet, LL	Economic Capture of CO_2 with Amines and Ionic Liquids Tethered in the Gas Phase	$69,479
Interdisciplinary Design Collaborative, LLC	Residential Energy Optimization Algorithms	$66,890
Lao K, LLC	Mill Trials of a Novel Formaldehyde-Free Soy-Based Wood Adhesive for Making Plywood	$69,975
Lynntech Inc.	Efficient Distributed Energy Generation System	$70,000
Lynntech Inc.	Improved Heterogeneous Catalyst for the Transesterification of Triglycerides to Biodiesel	$70,000
Membrane Technology and Research Inc.	Novel Membrane Process to Utilize Dilute Methane Streams	$70,000
Mobius Technologies, Inc.	Development of Micronized Polyurethane as a Comprehensive, 100 Percent Recycled Resin for Green Building Materials and Systems	$69,760
NEI Corporation	Self-Healing Corrosion-Control Coatings: An Enabling Technology To Restore Aging Water Infrastructure and Permit Alternative Water Use for Cooling	$69,996
Smart Polymers Research Corporation	Quantum Dot/Aptamer Real-Time Flow Sensor	$69,999
TDA Research Inc.	Thermochemical Biofuels Production from Biomass Waste Materials	$70,000
Technology Specialists	Development of a Simple, Robust, and Inexpensive Alkalinity Sensor	$69,660
Technova Corporation	Value-Added Use of Milled Mixed-Color Waste Glass as a Supplementary Cementitious Material in Environmentally Friendly and Energy-Efficient Concrete Building Construction	$70,000
Voxtel, Inc.	Real-time Detection and Identification of Chemical, Biological, and Explosive (CBE) Agents With Low False Alarm Rates	$69,996
Wireless Industrial Technologies, Inc.	Wireless Instrumentation for Control of Greenhouse Gas Emissions by the Aluminum Industry; Measurement and Monitoring of Current Distribution in Aluminum Reduction Cells	$70,000

Building Partnerships, Serving Regions, and Supporting Communities

Recipient	*Title*	*$ Awarded*
Omega Optics, Inc.	Photonic Crystal Slot Waveguide Spectrometer for Monitoring of Volatile Organic Compounds in Groundwater and Hazardous Pollutants in Air	$70,000
Applied Sciences, Inc.	Nano-Enhanced Composite Electrodes for Electrostatic Precipitators	$224,985
Bridger Photonics, Inc.	Hand-Held Sensor for Remotely Mapping Carbon Dioxide Pollution Sources	$225,000
Dr. Ben Curatolo, Inc. d.b.a. Light Curable Coatings	Chromium-Free Corrosion-Resistant Hybrid UV Coatings	$224,998
Ecovative Design, LLC	Development and Demonstration of a Low Embodied Energy, Construction Material that Replaces Expanded Polystyrene and Other Synthetic Materials	$225,000
Fuss & O'Neill	Development and Commercialization of Granular Activated Carbon Microbial Fuel Cells for Wastewater Treatment and Power Generation	$225,000
KWJ Engineering, Inc.	Reagentless Field-Usable Fixed-Site and Portable Analyzer for Trihalomethane (THM) Concentrations in Drinking Water	$224,713
Innova Tech, Inc.	Retrofit Air Pollution Control Filter for Restaurant Underfired Charbroilers	$224,996
Ion Signature Technology, Inc.	Development of an *In Situ* Thermal Extraction Detection System (TEDS) for Rapid, Accurate, Quantitative Analysis of Environmental Pollutants in the Subsurface	$224,786
Scientific Methods, Inc.	Rapid Concentration of Viruses from Water	$224,987
TDA Research Inc.	A Portable Microreactor System to Synthesize Hydrogen Peroxide	$225,000
Down to Earth Energy (formerly Mountain Creek Enterprises)	Commercialization of Solid Acid and Base Catalysts Derived from Biochar Optimized to Produce Biodiesel from Low Cost Oils	$225,000

EPA Extramural Research Grants and Fellowships for 2010

EPA funds research grants and graduate fellowships in numerous environmental science and engineering disciplines through its Science To Achieve Results (STAR) program.

The STAR program engages the Nation's best scientists and engineers in targeted research that complements EPA's own outstanding intramural research program and those of Agency partners in other federal agencies. Grants are awarded through a competitive solicitation process and independent peer review. Current Agency-supported research includes work on drinking water, water quality, global change, ecosystem assessment and restoration, human health risk assessment, endocrine disrupting chemicals, pollution prevention and new technologies, children's health, socio-economic research, and the health effects of particulate matter.

In addition, through this same competitive process, EPA periodically establishes large research centers in specific areas of national concern. Currently, centers focus on children's environmental health, hazardous substances, particulate matter, and estuarine and coastal monitoring.

During 2010, EPA's grants program awarded 103 new grants and processed incremental funding to continue to support critical ongoing projects. This $97.5 million investment in research supports broad goals of the Agency across the areas of drinking water; air pollution and global change; global change impacts on oceans, aquatic ecosystems, and air pollution; ecosystems; and human health.

Grants to Support Air, Climate, and Energy Research

Grants awarded for environmental and human health research in the areas of Air, Climate, and Energy during 2010 include the following:

- EPA awarded $32 million for four new Clean Air Research Centers (CLARC). The centers will conduct research addressing the problem of multiple pollutants and health impacts across life states, among susceptible and vulnerable populations, and across communities (environmental justice issues), and will study health effects from cardiovascular and pulmonary problems to neurological and inflammation outcomes.

  The four CLARCs are:
  -Emory University and Georgia Institute of Technology, Atlanta, GA. This center will combine novel measurement techniques with air pollution models to provide an assessment of the health risks of air pollution mixtures.
  -Michigan State University, East Lansing, MI. This center will focus on the effects of fine particulate matter and ozone on cardiovascular health by looking at important subpopulations at risk.
  -University of Washington, Seattle, WA. This center will integrate exposure, epidemiological, toxicological, clinical, and statistical sciences to study the cardiovascular hazards of recent and aged roadway emissions.
  -Harvard University, Boston, MA. This center will investigate the effects of short- and long-

Grants to Support Air, Climate, and Energy Research, *Cont'd.*

term exposures to individual pollutants, pollution sources, and multipollutant mixtures on the brain, cardiovascular system, inflammation, birth weight/growth, and cardiovascular disease.

- The Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air) is a $33 million, 10-year prospective epidemiology study to investigate the link between long-term exposure to air pollution and cardiovascular disease. This unprecedented study continues to investigate the impacts that fine particles in air pollution has on the health of a diverse group of more than 6,000 participants.
- EPA awarded 12 new research projects that will advance understanding of air pollution emission inventories. Results of this work are critical for improving the ability to accurately model pollution in the air that we breathe. The new projects provided a research portfolio addressing scientific needs in four specific areas:

1. Transportation - Projects investigating emissions from mobile sources and roadways will provide critical input needed for the latest generation of aerosol modules in air quality models. The research will enable links between transportation activity and road vehicle emissions, as well as emissions from ships, which significantly impact air pollution in port areas.
2. Animal operations and ammonia - Because ammonia emissions are one of the areas of greatest uncertainty in current emission inventories, projects will contribute to developing better tools for generating ammonia emission inventories from cattle, swine and chicken operations. Additional modeling experiments will improve the national ammonia emission inventory and test the effectiveness of control strategies.
3. Technique development - New strategies for analyzing data to develop emission inventories and new measurements will provide insight into missing or uncertain sources. New laboratory and modeling research that addresses the comparability of measurements from different laboratory systems will strengthen the comparability of data and impact how emissions are reported.
4. Coarse PM - An emission inventory for coarse PM, including details about the biological component of the particles, will be developed. This area is of particular concern in current health studies addressing coarse PM and is a high-priority scientific need of the Agency program offices.

- Three new projects will investigate how global change may impact the occurrence of allergic airway disease. This work will develop techniques for better measurements of pollen, understanding its production and predicting where it may have the largest health impact under future climate scenarios.

Grants to Support Air, Climate, and Energy Research, *Cont'd.*

- Two awards support research on the geologic sequestration of carbon dioxide to ensure safe and effective storage, mitigate potential risks and prevent endangerment of existing and potential sources of drinking water.
- Eight new projects will investigate how strategies to mitigate and adapt to a changing climate will affect air quality and air quality management. These projects focus on how changing transportation infrastructure, land use, development, and climate-focused policies will impact the ability to meet air quality goals.

Grants to Support Safe and Sustainable Water Research

EPA awarded ten projects, totaling $5,365,382, under the area of advancing public health water infrastructure sustainability. Broadly, the Request for Applications (RFAs) focused on improving the effectiveness of the water infrastructure, existing and future, for protecting public health and maximizing sustainability, reliability, and efficiency of water infrastructure.

Awarded projects will:

- Develop and test new water infrastructure system design and operation;
- Inform public health risk assessments associated with distribution vulnerabilities;
- Inform quantitative relationships between infrastructure conditions and public health risks associated with continuous, intermittent or episodic water quality deterioration or contamination; and
- Quantify the economic and energy aspects of strategies, tools, or concepts that prevent, mitigate and respond to infrastructure decay.

Seven grants (listed on the following page), funded for a total of more than $6 million were awarded in FY2010 to investigate the potential for the geological sequestration of carbon dioxide to affect underground sources of drinking water. Injecting carbon dioxide into depleted oil or gas fields and underground saline aquifers is increasingly being considered to remove large quantities of greenhouse gas from the atmosphere and help address climate change. This research is expected to lead to improved designs for carbon sequestration projects that will protect underground drinking water supplies.

Grants to Support Safe and Sustainable Water Research, *Cont'd.*

Recipient(s)	*Title*	*Amount Awarded ($)*
Innovative and Integrative Approaches for Advancing Public Health Protection Through Water Infrastructure Sustainability RFA		
Emory University	Measures of Distribution System Water Quality and Their Relation to Health Outcomes in Atlanta	$599,429
North Carolina State University	An Integrated Approach to Understanding and Reducing Fat, Oil, and Grease (FOG) Deposit Formation for Sustainable Sewer Collection Systems	$599,429
Advancing Public Health Protection through Water Infrastructure Sustainability RFA		
Water Research Foundation	Evaluation of Lead Service Line Lining and Coating Technologies	$600,000
Purdue University	Development of Mobile Self-Powered Sensors for Potable Water Distribution	$599,997
The University of Hawaii	Rapid Detection of Sewer Pipeline Problems Using Bacterial DNA Markers and Q-PCR Technology	$299,956
University of Connecticut	Enabling Potable Reuse of Wastewater Using Forward Osmosis: A Sustainable and Affordable Alternative to Reverse Osmosis	$300,000
University of Illinois at Champaign	Toxicity of Drinking Water Associated with Alternative Distribution System Rehabilitation Strategies	$599,113
University of Illinois at Urba-na-Champaign	Association of Pathogens with Biofilm in Drinking Water Distribution Systems	$600,000
University of Wisconsin	Evaluation of Sanitary Sewers as a Source of Pathogen Contamination of Municipal Water Supply Wells	$598,580
University of Alabama	Water Infrastructure Sustainability and Health in Alabama's Black Belt	$598,739

Grants to Support Chemical Safety for Sustainability

Three grants for a total of $6 million were awarded under a collaborative US/UK solicitation to assess the human health and environmental impacts of exposure to manufactured nanomaterials. The research produced with the support of the grants will help policy-makers better understand the potential adverse environmental and public health impacts of nanoscale materials.

Recipient(s)	*Title*	*Amount Awarded ($)*
Rice University, Clemson University, Edinburgh Napier University, Natural History Museum (London), University of Birmingham, University of California - Davis, University of Exeter	Consortium for Manufactured Nanomaterial Bioavailability & Environmental Exposure	$2,000,000
University of Medicine and Dentistry of New Jersey, Duke University , Imperial College	Risk Assessment for Manufactured Nanoparticles Used in Consumer Products (RAMNUC)	$1,999,995
University of Kentucky , Carnegie Mellon University , Centre for Ecology and Hydrology , Cranfield University , Duke University , Lancaster University , Rothamsted Research	Transatlantic Initiative for Nanotechnology and the Environment	$2,000,000

Grants to Support Human Health Research

On October 19-20, 2010, EPA hosted the "Protecting Children's Health for a Lifetime: Environmental Health Research Meets Clinical Practice and Public Policy" Conference in Washington, DC. The meeting brought together federal and professional organizations to explore the interplay between research, clinical applications and policy implications in the field of children's environmental health. The meeting also marked the launch of the next phase of the Children's Environmental Health and Disease Prevention Centers program—a partnership among EPA and the National Institute of Environmental Health Sciences (NIEHS)—with 12 new grants for a total of nearly $60 million over the next five years. Together, EPA and NIEHS are funding six new grants for large multidisciplinary research (5-year) Centers and six new grants (3-year) for "Formative Centers."

Grants to Support Human Health Research, *Cont'd.*

Under the *Understanding the Role of Nonchemical Stressors and Developing Analytic Methods for Cumulative Risk Assessments* RFAs, EPA awarded a total of more than $7 million through seven grants.

Recipient(s)	*Title*	*Amount Awarded ($)*
University of Pittsburgh (Main Campus), Harvard School of Public Health, New York University, West Harlem Environmental Action	Community Stressors and Susceptibility to Air Pollution in Urban Asthma	$1,250,000
University of Rochester School of Medicine and Dentistry	Combined Effects of Metals and Stress on Central Nervous System Function	$1,250,000
University of Medicine and Dentistry of New Jersey	Effects of Stress and Traffic Pollutants on Childhood Asthma in an Urban Community	$1,249,960
University of Texas School of Public Health, National Chiao-Tung University, University of Texas M. D. Anderson Cancer Center	Hypertension in Mexican-Americans: Assessing Disparities in Air Pollutant Risks	$1,250,000
Boston University	New Methods for Analysis of Cumulative Risk in Urban Populations	$749,226
University of Texas School of Public Health, University of North Carolina, University of Texas Medical Branch - Galveston	Analytical Strategies for Assessing Cumulative Effects of Chemical and Nonchemical Stressors	$555,923
Harvard School of Public Health, Channing Laboratory	Effects-Based Cumulative Risk Assessment in a Low-Income Urban Community Near a Superfund	$749,662

Grants to Support Healthy and Sustainable Communities Research

In partnership with the U.S. Department of Agriculture, EPA awarded a number of grants to support research on methods that could be used to estimate the variety of ecosystem services associated with agricultural settings. Collectively, the supported research aims to develop quantitative strategies to reduce the negative environmental impacts of agriculture while enhancing the ecosystem services of the land.

Recipient(s)	*Title*	*Amount Awarded ($)*
Archbold Expeditions	Assessing Trade-Offs Among Ecosystem Services in a Payment-for-Water Services Program on Florida Ranchlands	$498,835
Oregon State University	Enhancing Ecosystem Services in a High Risk Agroecosystem of the Interior Pacific Northwest in the Face of Climate Change and Land Use Intensification	$500,000

EPA-supported Children's Environmental Health Science

EPA and the National Institute of Environmental Health Sciences support a series of Children's Environmental Health Centers across the country. Researchers at one such center, the Columbia Center for Children's Environmental Health, published two major findings in 2010:

- *Chlorpyrifos Exposure and Urban Residential Environment Characteristics as Determinants of Early Childhood Neurodevelopment*, presented in the online edition of the *American Journal of Public Health*, found that exposure to the pesticide chlorpyrifos—banned for use in U.S. households but still widely used throughout the agricultural industry—is associated with developmental delays in early childhood.
- *Prenatal Acetaminophen Exposure and Risk of Wheeze at Age 5 Years in an Urban Low-Income Cohort*, published in the February 2010 issue of the journal *Thorax*, presents findings that children who were exposed to acetaminophen prenatally were more likely to have asthma symptoms at age 5. This was the first study to demonstrate a direct link between asthma and an ability to detoxify foreign substances in the body.

EPA and NASA Administrators Extend Environmental and Earth Science Partnership

On April 26, 2010, EPA Administrator Lisa P. Jackson and National Aeronautics and Space Administration (NASA) Administrator Charles Bolden joined forces at the Howard University Middle School of Mathematics and Science to stress the importance of science and engineering education. The administrators chose the Howard University Middle School to underscore the importance of promoting math and sciences among the next generation of leaders.

At the event, the administrators also signed a Memorandum of Agreement (MOA) to foster cooperation between the two agencies in environmental and earth sciences and applications. As two science leaders in government, both administrators challenged the students to continue a pursuit of science and excellence.

The signed MOA promotes renewed efforts of collaboration between EPA and NASA to improve environmental and earth science research; technology; environmental management; and the application of earth science data, models, and technology in environmental decision-making. Areas of applied research and applications expected to benefit from this partnership include climate change, air quality and water. The re-invigorated partnership focuses on science leadership to motivate continued exploration, innovation, and protection of our home planet.

For more information on EPA's Earth Observations and Advanced Monitoring Initiative, visit www.epa.gov/geoss/.

Sharing EPA Science

EPA joined 500 science and research organizations at the USA Science & Engineering Festival.

EPA scientists and engineers shared their work with students and families from across the country at the inaugural USA Science & Engineering Festival held October 23-24, 2010, on the National Mall in Washington, DC.

The activities associated with the festival began with inspirational talks by "Nifty Fifty" science ambassadors, including EPA's Dr. Paul Anastas (Assistant Administrator for EPA's Office of Research and Development) and Dr. Kevin Teichman (Deputy Administrator for Science, Office of Research and Development) who visited two schools in the Washington, DC, area to share their love of science and inspire the next generation of innovators. Nifty Fifty scientists were carefully chosen from hundreds of applicants for their differing fields, talents, divergent backgrounds and ages, and ability to convey the importance of science to students.

The month-long celebration culminated with the 2-day festival expo on the National Mall in Washington, DC.

The expo featured more than 1,500 interactive stations from more than 500 of the country's top science and engineering organizations, including EPA. The EPA exhibit featured activities that demonstrated the kinds of research that Agency scientists are conducting across the country and highlighted what that research meant for the protection of public health and the environment.

2010 EPA *Scientific Publications*

MARR, D., M. A. MASON, R. B. MOSLEY, X. LIU, Z. GUO, AND C. WHITFIELD. "Building air change rate due to natural ventilation induced by open windows and door in a residential property." Presented at IAQVEC 2010, Syracuse, NY, August 30, 2010.

BETANCOURT, D. "Characterization of Stachybotrys chartarum microbial volatile organic compounds (MVOC) emissions and mycotoxins production on gypsum wallboard." Presented at International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings, Syracuse, NY, August 15 - 18, 2010.

MARR, D. "An analysis of the BIFMA M7.1 test method model efficacy and uncertainty via emissions measurements." Presented at IAQVEC 2010, Syracuse, NY, August 15 - 17, 2010.

MARR, D. "The incorporation of CFD capabilities with RISK, an indoor air quality zonal model developed by the U.S. EPA." Presented at American Physical Society, Long Beach, CA, November 21 - 23, 2010.

MARR, D. "Radon tracer as a multipurpose tool to enhance vapor intrusion assessment and mitigation." Presented at AWMA Vapor Intrusion 2010, Chicago, IL, September 29, 2010.

JETTER, J. J. "Solid-fuel cook stoves: Fuel efficiency and emissions testing." Presented at Indoor Air 2011, Austin, TX, June 05, 2011.

MARR, D. "Radon tracer as a multipurpose tool to enhance vapor intrusion assessment and mitigation--poster." Presented at AWMA Vapor Intrusion 2010 Conference, Chicago, IL, September 29, 2010.

Lutes, C. C., R. Uppencamp, H. Hayes, R. B. MOSLEY, AND D. J. GREENWELL. "Long-term monitoring of ultrafine and accumulation-mode particulate matter during the Las Vegas Near-Road Study." Presented at AWMA Vapor Intrustion 2010, Chicago, IL, September 29, 2010.

HAYS, M. D. "Analytical activities at the U.S. EPA regarding organic particulate matter." Presented at Analytica 2010, Munich, GERMANY, March 23 - 26, 2010.

KINSEY, J. S. "Determination of the fine particle emissions from wood-fired hydronic hatrs." Presented at American Association of Aerosol Research, Portland, OR, October 25, 2010.

HAYS, M. D. "Particle size distribution of metal and non-metal elements in an urban near-highway environment." Presented at American Association of Aerosol Science, Portland, OR, October 25 - 29, 2010.

HAGLER, G. "The effect of vegetative and structural barriers on ultrafine particle and carbon monoxide dispersion in near-roadway communities." Presented at American Association of Aerosol Research, Portland, OR, October 25, 2010.

HAGLER, G. "Long-term monitoring of ultrafine and accumulation-mode particulate matter during the Las Vegas Near-Road Study." Presented at American Association of Aerosol Research, Portland, OR, October 25, 2010.

SHORES, R. C. "EPA's mobile monitoring of source emissions and near-source impact." Presented at AWMA measurements conference, Los Angeles, CA, October 15, 2010.

KHAN, B. "Using thermal-optical analysis to examine the OC-EC split that characterizes ambient and source emission aerosols." Presented at 2010 AGU Fall Meeting, San Francisco, CA, December 13 - 17, 2010.

BALDAUF, R. W. "The effect of roadside barriers on near-road air quality." Presented at 2010 CRC Mobile Source Air Toxics Workshop, Sacramento, CA, November 30, 2010.

BALDAUF, R. W. "FHWA/EPA near-road study in Las Vegas." Presented at 2010 CRC Mobile Source Air Toxics Workshop, Sacramento, CA, November 30 - December 02, 2010.

HAGLER, G. "Current research in NRMRL on the mitigation of near-road air pollution by vegetative and structural barriers." Presented at NRMRL and EPA Ecology NPD web site, RTP, NC, February 15, 2010.

KIMBROUGH, E. S. "Las Vegas Part 2, Traffic analysis and study design." Presented at Near-road general stakeholders meeting, Raleigh, NC, March 01, 2010.

KIMBROUGH, E. S. "Las Vegas Part 1, Traffic analysis and study design." Presented at Near-road general stakeholders meeting, Raleigh, NC, March 01, 2010.

KIMBROUGH, E. S. "The National Near-Road Mobile Source Air Toxics Study: Las Vegas" (Poster)." Presented at AWMAConference--Calgary 2010, Calgary, AB, CANADA, June 22 - 26, 2010.

KIMBROUGH, E. S. "Characterization and variability of the pollutant [illegible] Road Mobile Source Air Toxics Study." Presented at AWMA Calgary [illegible] - 26, 2010.

HAGLER, G. "A field and modeling study to assess the potential mitig[illegible] Presented at AWMA Calgary 2010, Calgary, AB, CANADA, June 22 - 26, 2010.

KIMBROUGH, E. S. [Several Presentations about EPA Near-road air pollution research] Presented at General Stakeholders Meeting (Near-Road Research), Research Triangle Park, NC, March 01, 2010.

KIMBROUGH, E. S. "EPA/FHWA Near Road Collaboration Project: Las Vegas monitoring data--continuous analyzer and integrated PM data." Presented at Federal stakeholders meeting, Research Triangle Park, NC, March 01, 2010.

HAGLER, G. "Detroit mobile air monitoring research." Presented at General stakeholders meeting (near-road research), Research Triangle Park, NC, March 01, 2010.

HAGLER, G. "EPA/FHWA Near Road Collaboration Project: Ultrafine particle monitoring research." Presented at Federal stakeholders meeting, Research Triangle Park, NC, March 01, 2010.

HAYS, M. D. "Analytical activities at the U.S. EPA regarding organic particulate matter." Presented at Analytica Munich, Munich, GERMANY, March 24 - 26, 2010.

HAGLER, G. "Organic and elemental carbon in central Greenland air and snow: Towards a better understanding of sources, source regions and radiative forcing." Presented at State of the Artic, Miami, FL, March 16 - 20, 2010.

KIMBROUGH, E. S. "EPA/FHWA Near-Road Study--Characterization and variability of pollutant concentrations." Presented at AAAR 2010, San Diego, CA, March 22 - 26, 2010.

KIMBROUGH, E. S. EPA/FHWA "Near Road Study--Las Vegas implementation and experience." Presented at AAAR 2010, San Diego, NC, March 22 - 26, 2010.

HAGLER, G. "How does vegetation affect pollutant transport and disperson?" Presented at Role of vegetation in mitigating near road air qualtiy, Research Triangle Park, NC, April 27, 2010.

HAGLER, G. "Modeling vegetation near I-40/I-85 in Mebane, NC.: Presented at Role of vegetation in mitigating near road air quality, Research Triangle Park, NC, April 27, 2010.

BALDAUF, R. W. "Why are we concerned with near-road air quality?" Presented at Role of vegetation in mitigating near road air quality, Research Triangle Park, NC, April 27, 2010.

HAYS, M. D. "Analytical activities at the U.S. EPA related to PM and transportation." Presented at Transportation Technologies and Fuels Forum, Ottawa, QC, CANADA, May 10 - 11, 2010.

KIMBROUGH, E. S. "EPA/FHWA Near Road Collaboration Project: Las Vegas Monitoring Study--Concentrations of Pollutants in the Near Road Environment in Las Vegas, NV." Presented at TRB Environment and Energy Research Conference, Raleigh, NC, June 08, 2010.

[illegible] dynamics modeling to assess the impact [illegible] roadside barriers on near-road air quality: slides." Presented [illegible] or Computational Wind Engineering, Chapel Hill, NC, May 24 - 27, 2010.

KINSEY, J. S. "Development of calibration procedures for non-volatile particulate matter mass measurement methods." Presented at 8th Meeting of Primary Contributors to aviation air pollution research, Research Triangle Park, NC, May 10 - 19, 2010.

HAGLER, G. "Spatial gradient analysis and effect of near road design." Presented at Transportation Research Board Environment and Energy Conference, Raleigh, NC, June 06 - 09, 2010.

KINSEY, J. S. "Determination of the fine particle emissions from alternate aviation fuels." Presented at Transportation Research Board Environment and Energy conference, Raleigh, NC, June 06 - 09, 2010.

THOMA, E. D. "Detection and quantification of fugitive emissions from Colorado oil and gas production operations using remote monitoring--slides." Presented at 103rd Annual Conference of the Air & Waste Management Association, Calgary, AB, CANADA, June 22 - 25, 2010.

BALDAUF, R. W. "Workshop on the role of vegetation in mitigating air quality impacts from traffic emissions." Presented at web material for web site local to RTP EPA, Research Triangle Park, NC, June 17, 2010.

MARR, D. "The influence of opening windows and doors on the natural ventilation rate of a residential building--slides." Presented at IAQVEC 2010, Syacruse, NC, August 15, 2010.

BALDAUF, R. W. "Vegetation Influences on Near-Road Air Quality." Presented at NTAQS 2010, Cambridge, MA, August 25, 2010.

"Promise. That's what research is. A promise that if we engage in this often difficult scientific endeavor, then we will understand the world better and be able to make the world a better place."

Paul T. Anastas, Ph.D.,
Assistant Administrator
Office of Research and Development, U.S. EPA

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