[JERALD l. SCHNOOR TESTIMONY]

House Subcommittee on Energy and the Environment

Hearing on "Fostering Quality Science at EPA: Perspectives on Common Sense Reform – Day II"

Room 2318 Rayburn House Office Building

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Good Morning Chairman Dr. Harris, Ranking Member Miller, Distinguished Committee Members, Ladies and Gentleman… Thank you for the chance to testify before the Subcommittee. I am Jerald Schnoor, Professor of Civil and Environmental Engineering at the University of Iowa and Co-Director of the Center for Global and Regional Environmental Research. I am also Editor-in-Chief of the American Chemical Society journal, *Environmental Science and Technology*, a leading journal in environmental science and engineering. I have had the good fortune to teach and perform research in the environmental area for over 35 years. During that time, I served as the Chair of the Board of Scientific Counselors for EPA Office of Research and Development (ORD) from 2000-2004, and more recently as a member of the Science Advisory Board (SAB) to EPA. I also am a member of the National Academy of Engineering and, as such, have served on a number of National Research Council committees of the National Academies, including one which I am chairing now on science for EPA's future. So I come to you with shared interest in fostering quality science at EPA, and I have organized my testimony in response to the questions posed to me in the invitation letter from Chairman Harris dated January 25, 2012.

What constitutes quality science to support EPA's mission? EPA's mission is to protect human health and the environment from detrimental effects of pollution and other hazards. Thus, EPA's science should be relevant to its mission; it should be of high quality and high priority; and it should be reviewed by qualified scientists and engineers. Such high quality science enables excellent policy judgments to be made by decision-makers. In addition, EPA science should help to identify future and emerging environmental issues.

One recent example which illustrates how quality science can help to inform policy even in a time of crisis involved the Macondo oil spill on April 20, 2010, and the subsequent release of almost 200 million gallons of oil and addition of two million gallons of dispersant to the Gulf of Mexico. Shortly after the accident occurred, EPA was asked about the toxicity of the dispersant that was chosen to break-up the oil plume. The toxicological data on dispersants at the time were sparse, but EPA-ORD rapidly engaged in high-throughput testing on eight commercial dispersants at the National Center for Computational Toxicology in the EPA Lab at Research Triangle Park, North Carolina. EPA scientists learned quickly that Corexit 9500, the dispersant used, was comparable or relatively less toxic than other alternative products. In fact, EPA scientists performed the research, wrote and submitted a scientific journal article, and subsequently published the peer-reviewed results on June 30, 2010, only ten weeks after the original explosion and release of oil (Judson et al., 2010) – a remarkable accomplishment. Those events point to another characteristic of quality science – it should be timely.

EPA should provide high-quality science to inform regulatory decisions. As a research engineer and editor, I can testify that the Office of Research and Development offers world-class science in a number of areas including air quality monitoring, modeling and development of emissions databases. Improvements in air quality that the U.S. has achieved over the past 40 years are a testament to the good science at EPA. Let's consider air quality in recent decades in the U.S. as a case study for sound science to improve human health and the environment.

Increasing population and consumption are "drivers" serving to elevate emissions both in the U.S. and globally. If one wants to "keep up" with ever increasing pollution from these drivers, it requires increasingly stringent regulations just to maintain the status quo. For the most part, U.S. greenhouse gas emissions (CO_2-equivalents) have mirrored the increasing population which continues to grow at about one percent per year. Figure 1 shows the lock-step of increasing CO_2 emissions, population, and energy consumption in the U.S. since 1990. They track each other closely, and increasing population and energy consumption result in greater CO_2 emissions. Note that CO_2 emissions have not increased nearly as rapidly as the Gross Domestic Product (GDP), which indicates improved efficiency in a changing economy. Also, the trend in the transportation sector, responsible for approximately one-quarter of all greenhouse gases (GHGs), shows that Americans drove many more miles during this period. Vehicle miles traveled increased 36% from 1990-2008, but the rate of release of greenhouse gas emissions due to transportation has been much less, especially in recent years.

The surprising news from Figure 1 is that six aggregate air pollutants have been reduced by 41% over the 18-yr period. This illustrates a tremendous success story which constitutes lives saved, better respiratory health for millions, and billions of dollars in medical costs avoided, not to mention cleaner/purer air. The U.S. achieved these results by virtue of a steadfast EPA adopting new rules and enforcing the Clean Air Act and its amendments. The Clean Air Act is the most expensive legislation to enforce in the entire U.S. code, but it has a highly positive benefit-to-cost ratio and has resulted in lower morbidity and mortality due to lung and cardiovascular disease, and the creation of many jobs by achieving and abiding by the new standards (CERES, 2010). CERES, an organization that articulates the views of major American corporations on their social responsibilities, recently estimated that enforcement of the National Ambient Air Quality Standards alone will result in the creation of 1.5 million jobs over the next five years. The country needs clean energy and clean air as well as high-paying jobs, and the former can augment the latter. In March 2011, EPA issued *The Benefits and Costs of the Clean Air Act from 1990-2020*. According to this study, the direct benefits from the 1990 Clean Air Act Amendments are estimated to be almost \$2 trillion for the year 2020, exceeding costs by a factor of more than 30:1.

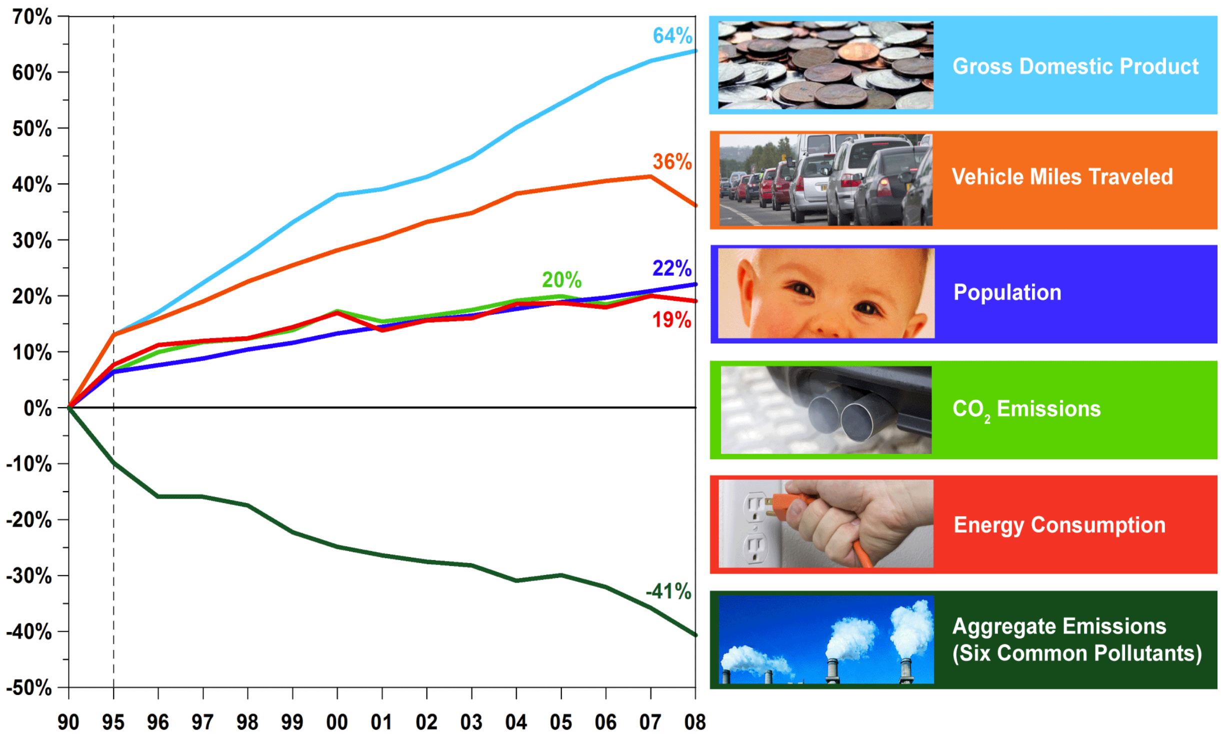


Figure 1. Gross trends in aggregate emissions, carbon dioxide emissions, and their drivers (GDP, VMT, population, and energy consumption) since 1990 in the U.S. (Source: U.S. Environmental Protection Agency, Office of Research and Development, Strategic Plan, 2011)

From Figure 2, one can see the large decline in specific emissions of NO_X (30 %), Volatile Organic Chemicals (VOC, 53%), carbon monoxide (CO, 54%), sulfur dioxide (SO_2, 55%), and particulate matter less-than-10 microns (PM_{10}, 65%) since the inception of EPA in 1970, and the implementation and enforcement of the Clean Air Act and its Amendments (1967, 1976, 1990). Despite a doubling of the U.S. GDP during this period (and large increases in vehicle-miles-traveled, population, energy consumption, and CO_2 emissions), regulation of the transportation and industrial sectors has allowed a decline in emissions of air pollutants. Note, however, that the majority of emission reductions from 1970-2005 in Figure 2 occurred prior to 1995 (with the exception of NO_X), illustrating that the rate of improvements have slowed.

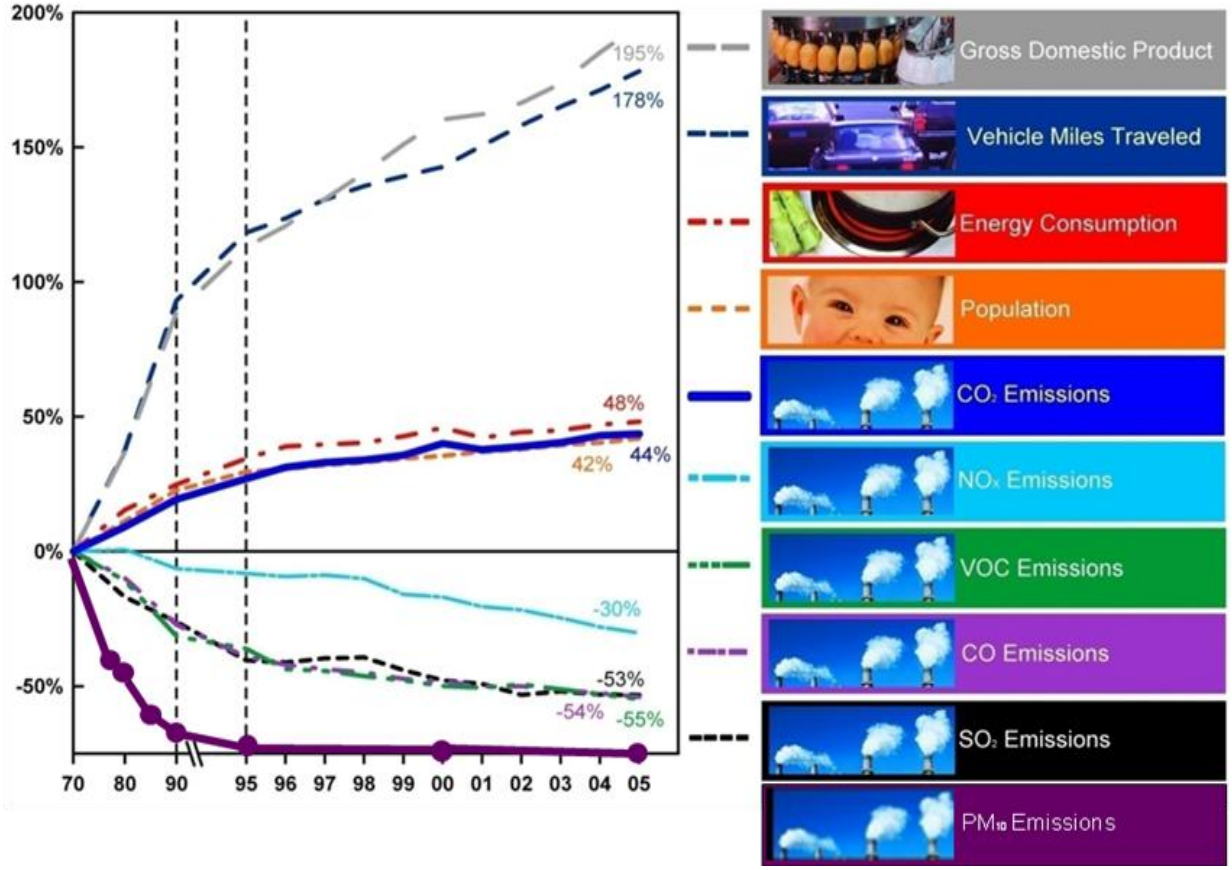


Figure 2. Detailed trends in specific pollutants and drivers since the inception of EPA in 1970. (Source: U.S. Environmental Protection Agency, Office of Research and Development, Strategic Plan, 2011)

Sometimes, there is no single entity or agency that is sufficiently interested, capable, or funded to perform research necessary to protect human health and the environment from pollution. Many times, it is advantageous to form partnerships to combine expertise and resources. A case-in-point is science to understand the emissions, fate, and effects of fine particulate matter (PM2.5) in the 1990s. EPA partnered with the National Institute of Environmental Health Sciences (NIEHS), and the Electric Power Research Institute (EPRI) to fund this seminal research. The famous Harvard Six Cities Study (Dockery et al., 1993) found evidence that not only lung cancer mortality was elevated when fine particles were prevalent in the air of U.S. cities, but cardiopulmonary disease also increased. However, the etiology of the disease, the cause of cardiopulmonary mortality, was unknown. How could fine particles cause disease, let alone death by heart attack or stroke? So it must have been with some trepidation that EPA began to develop regulations in 1996 to regulate fine particulate matter less than 2.5 microns in diameter (PM2.5) in order to protect the public health.

Today scientists have a much better idea of how fine particles can kill. In 2000, a reanalysis of the Harvard Six Cities Study was reported by the Health Effects Institute (HEI) and, in 2004, research was completed that validated the initial morbidity results (Krewski et al., 2004). An extended follow-up study by Francine Laden and colleagues was published in 2006 (Laden et al, 2006) and a summary of the beneficial effects on life expectancy by Pope et al. (2009). Laden was quoted in a Harvard School of Public Health Press Release at the time:

> "*The follow-up study found that an average of three percent fewer people died for every reduction of one microgram per cubic meter in the average levels of PM2.5 fine particulate matter, defined as having a diameter of 2.5 microns or less – narrower than the width of a human hair. This decreased death rate is approximate to saving 75,000 people per year in the U.S.*"

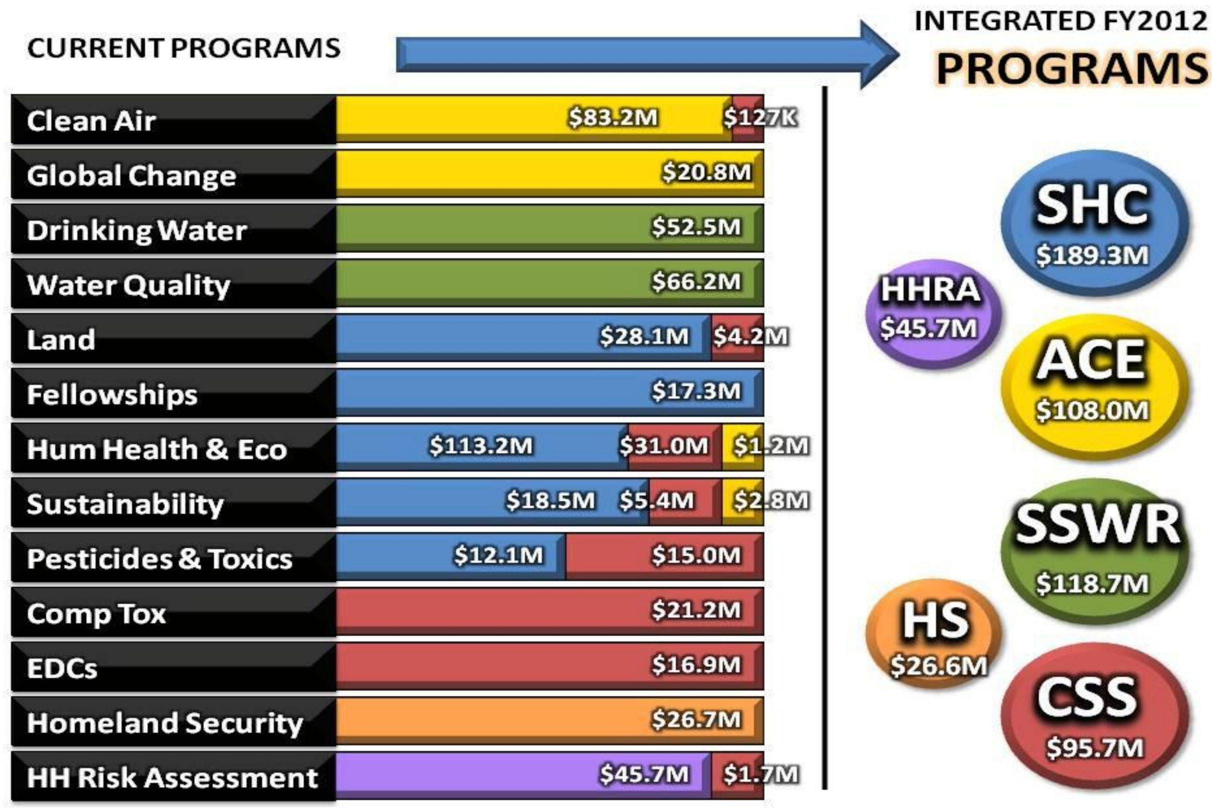
That's an example of quality science performing well – hypotheses are followed by hypothesis testing. Continual challenges in the peer-reviewed literature are followed by subsequent publication and peer-review, and iterated for further scrutiny of the results until the conclusion emerges and new questions arise. Today EPA funds research at the Rochester PM research Center and the Southern California Particle Center on the health effects of even finer particles, ultrafine particulate matter (UFP). EPA's (2011) Progress Report states, "Ultrafine particulate matter (UFP) is easily transported throughout the body even beyond the cardiopulmonary system. Tissue and cell analysis shows evidence for the translocation of UFP to the liver, kidneys and central nervous system. 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."

How does EPA currently produce quality science? Science is performed by the Office of Research and Development (ORD), by EPA Agency Offices (e.g., Office of Water), through extramural grants and contracts, and through small funding to the EPA Regional Offices and states (NRC, 2000). Science to inform EPA regulations is developed throughout the Agency, conveyed to the Administrator's Office, and utilized accordingly. Of course, funding is provided through the budgetary process and Congress, and oversight is performed by GAO, OMB, and others. EPA employs a strategic planning process to utilize science effectively. ORD seeks to maintain a balance between "problem-driven" research to address immediate policy and regulatory needs and "core" research in the basic environmental sciences, including research to understand future and emerging issues. ORD recently implemented a strategy to support innovation at the bench in ORD laboratories, demonstrate the power of trans-disciplinary research, broaden their network of problem solvers (crowd sourcing), and to showcase the products of such research.

Partnerships are formed within EPA offices and across outside agencies and institutions to perform both intramural and extramural research. Peer-review of major products and publications is the system by which objective evaluation and criticism of the science occurs. Increasingly, the National Research Council of the National Academies has played an important role in peer-review and advice to the Agency. Considering the importance of air quality for the Agency and the nation, EPA contracted with NRC to produce a series of reports advising the Agency on airborne particulate matter in the late 1990s and early 2000s. These were viewed as quite helpful at a critical juncture in scientific research to inform rule-making and policy (NRC, 1998; NRC, 1999). In addition, three FACA committees provide a wide range of important scientific peer review and advice: the Science Advisory Board (SAB), the Board of Scientific Counselors (BOSC), and the Clean Air Scientific Advisory Committee (CASAC). The SAB reviews the President's Budget request, and provides reviews on various reports which the Agency produces. BOSC provides advice on management of ORD, its multi-year program plans, and reviews of its various Centers, Laboratories and Divisions. Of course, CASAC reviews air pollution reports, rules and regulations.

The Office of Research and Development (ORD) provides a significant portion of scientific research for the Agency. In 2011, EPA ORD realigned their programs from 13 to six (Figure 3). The realignment was in concert with advice provided in recent years by both the Science Advisory Board (SAB) and the Board of Scientific Counselors (BOSC). Thirteen major programs proved somewhat unwieldy, and the realignment has received positive review from the SAB (SAB, 2011). Motivation for this consolidation and realignment of programs reflects an emphasis on integrated trans-disciplinary research, multi-pollutant exposures, and sustainability. These are not new programs, but represent a new way of thinking within ORD. Considerable synergies may be realized in combining research into the four programmatic areas: Air, Climate and Energy; Safe and Sustainable Water Resources (water quality plus drinking water); Sustainable and Healthy Communities; and Chemical Safety for Sustainability; plus two smaller programs in Homeland Security Research and Human Health Risk Assessment (Figure 3).

I believe ORD's realignment is wise, moving EPA research in a new and effective direction. ORD is moving from a *risk management paradigm*, which has guided and influenced research over the past two decades, towards a *sustainability paradigm.* That effort will pay dividends. It is consistent with a public health approach of "preventing disease" rather than a medical approach to "treating disease" after it occurs, and it recognizes that environment and health are an interconnected system. And it follows on early pioneering research which EPA did on Pollution Prevention in the 1990s. Restructuring EPA's research programs, however, is a significant challenge to an established Agency, and ORD must effectively translate research results from these new amalgamated programs into scientifically-informed environmental policy.



Key to ORD Program Acronyms

ACE	Air, Climate and Energy Research Program
CSS	Chemical Safety for Sustainability Research Program
HHRA	Human Health Risk Assessment
HSR	Homeland Security Research Program
SHC	Sustainable and Healthy Communities Research Program
SSWR	Safe and Sustainable Water Resources Research Program

Figure 3. Realignment of EPA ORD's many programs into four large programs (ACE, CSS, SHC, and SSWR and two small ones (HHRA and HSR), 2011

What improvements are needed for future science at EPA?

With a 41 year history, EPA finds itself in the second decade of the new Millennia with different challenges and variable public support for its mission to protect human health and the environment. EPA has successfully controlled pollution and improved public health and welfare since it was formed in 1970. Success has stemmed largely from establishment and enforcement of its regulatory programs under the Safe Drinking Water Act, the Clean Air Act, FIFRA, Superfund, TSCA, and others. Those successes have been informed by good research, both intramurally and extramurally, within the Agency and outside the Agency by universities, colleges, and partnering agencies/institutions.

But EPA has been successful in reducing pollution mainly at the *local* scale for single *conventional* pollutants where the legislative mandate was strong. Now, our environmental problems are at larger scale (regional to global) and involve aspects without solid legislative authority (e.g., agricultural runoff, land use and climate change, and choice of energy systems). Some factors driving these new challenges to human health and the environment in the U.S. include the following:

- Population growth and geographic shifts towards the South, West, and the coasts
- Land use change (urban sprawl, coastal development, agricultural practices)
- Energy Choices (biofuels, shale gas by hydraulic fracturing, deep off-shore oil, oil sands, coal bed methane, concentrated solar power, wind energy)
- Increased Consumption and Technological changes (globalization of trade and invasive species, e-waste and complexity of new electronic devices from 11 to 60 elements of the periodic table, new plastics and flame retardants, endocrine disrupting chemicals)
- Climate change (increased precipitation intensity, changing precipitation patterns, increasing floods, droughts, forest fires, tornadoes, hurricanes)

These factors have resulted in a new suite of emerging environmental challenges for EPA:

- Air quality deterioration due to warmer, moister climate
- Agricultural runoff and nutrient quality criteria from climate change and land use choices
- Urban stormwater and by-pass exacerbated by sprawl and storm severity
- Terrestrial ecosystem degradation (loss of species such as birds, bees, butterflies, bats)
- Coastal waters ecosystems degradation (harmful algal blooms, red tides, and hypoxia)

EPA's science in the future will require a new and innovative approach to investigating problems of broader scope where legislative mandates are not strong. Land use change, energy choices, coastal development, and climate change represent "wicked" problems of the future for which quality science is needed to chart the path forward.

EPA must employ the most modern, emerging technologies and tools to address these problems. A nimbleness and adaptability will be required to identify new environmental threats. Partnering and networking with other agencies, other countries, and U.S. citizenry to fashion creative innovative solutions to thorny problems must become the norm. Every form of efficiency and innovation will be necessary. Certainly, a science budget commensurate to these pressing problems and sufficient to support policy decisions and regulatory actions will be needed to protect human health and the environment in the future. This includes better use of social, behavioral and decision scientists who understand how to develop alternative approaches for desired environmental behaviors, rather than end-of-pipe command-and-control regulations. Sometimes there is no alternative to direct control and regulation, but EPA must think more creatively and seek market and behavioral solutions when they present themselves.

Given the planned shift toward multi-pollutant cumulative risk assessment and the backlog of ten thousand chemicals that need to be assessed, there is a need to invest in modernizing the human risk assessment approach to move beyond the one-pollutant-at-a-time framework. ORD should develop a clear plan for how the outputs of the Chemical Safety for Sustainability (CSS) program (e.g., Tox 21, NexGen) will be used by the Human Health Risk Assessment program.

The Safe and Sustainable Water Resources SSWR program will need to increase their focus on viewing water and wastewater holistically as an integral part of the overall water cycle. Wastewater is not a "waste", but rather a resource from which we will recover water, nutrients, and energy for reuse, and it will be used to make communities more socially, economically, and environmentally sustainable. This is in concert with EPA's changing role from not only a regulatory agency, but to one that promotes sustainable and healthy communities.

Lastly, EPA should assume leadership in the social, behavioral and decision sciences more broadly as an explicit research enterprise and cross-cutting strategy. Scientific research in these areas is inexpensive relative to the costs involved in much of the physical and biological sciences. Relatively modest investments in this cross-cutting domain could have large future benefits to protect human health and the environment (SAB, 2011).

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