

US EPA ARCHIVE DOCUMENT

Sustainable and Healthy Communities (SHC)
Strategic Research Action Plan
FY 2016 – 2019

Pre-Publication Draft

Table of Contents

Executive Summary.....	5
Introduction	7
Environmental Problems and Program Purpose	7
Problem Statement.....	9
Program Vision.....	9
Program Design.....	10
Building on the 2012-2016 Program.....	11
EPA Partner and Stakeholder Involvement	13
Integration across the Research Programs.....	15
Research to Support EPA's Strategic Plan.....	16
Statutory and Policy Context	19
Research Program Objectives.....	20
Research Topics	24
Anticipated Research Accomplishments and Projected Impacts	39
Conclusion.....	41
APPENDIX: Summary Table of Anticipated Outputs.....	42
Glossary.....	Error! Bookmark not defined.

List of Acronyms

ACE Air, Climate and Energy

AOPs adverse outcome pathways

AWQC Ambient Water Quality Criteria

BMP Best Management Practices

CCL Contaminant Candidate List

CECs Contaminants of Emerging Concern

CERCLA Comprehensive Environmental Response, Compensation and Liability Act –“Superfund”

CSO Combined sewer overflow

CSS Chemical Safety for Sustainability

CWA Clean Water Act

DoD Department of Defense

EPA Environmental Protection Agency

EPA Strategic Plan FY 2014–2018 EPA Strategic Plan

GI green infrastructure

HABs Harmful Algal Blooms

HAWQS Hydrologic and Water Quality System

HHRA Human Health Risk Assessment

HSPF Hydrologic Simulation Program FORTRAN

HSRP Homeland Security Research Program

NEPA National Environmental Policy Act

ORD Office of Research and Development

PIPs Pathfinder Innovation Projects

RARE Regional Applied Research Effort

RCRA Resource Conservation and Recovery Act

SDWA Safe Drinking Water Act

SHC Sustainable and Healthy Communities

SSWR Safe and Sustainable Water Resources

SSWR Safe and Sustainable Water Resources

STAR Science to Achieve Results

StRAP 16-19 SSWR Strategic Research Action Plan, 2016–2019

SWAT Soil Water Assessment Tool

SWMM EPA's Stormwater Management Model

UCMR Unregulated Contaminants Monitoring Rule

UST Underground Storage Tanks

VELMA Visualizing Ecosystems for Land Management Assessments

WMOST Watershed Management Optimization and Support Tool

Sustainable and Healthy Communities

Strategic Research Action Plan

Fiscal Years 2016 - 2019

Executive Summary

How do we meet today's needs without compromising the ability of future generations to meet their needs? And more specifically, how can we take action to protect our shared environment—air, water, land, and ecosystems—in ways that are economically viable, beneficial to human health and well-being, and socially just in the long term?

EPA's Sustainable and Healthy Communities research program is working to provide the knowledge, data, and tools needed to answer those questions. The program is focused on providing information and tools to EPA program and regional offices and U.S. communities to inform decisions that produce more sustainable outcomes for the environment, society, and economy.

This *Strategic Research Action Plan* outlines the Office of Research and Development's role in achieving EPA's objectives for cleaning up communities, making a visible difference in communities, and working toward a sustainable future. It was developed with considerable input and support from partners within EPA program and regional offices, as well as from outside stakeholders such as community leaders, other federal agencies, nonprofit organizations, and colleagues across the scientific community. It includes research and development to generate and provide access to environmental science on health, well-being, and the environment, and to place that science in the context of the critical decisions facing communities. This plan also contains research and development focused on some of our nation's most pressing issues – contaminated sites, oil spills, and waste management.

The Sustainable and Healthy Communities research program is designed to develop research and tools that offer solutions to community-based decision-makers, inside and outside EPA. SHC is committed to providing high quality information in user-friendly formats to help optimize community decisions across the three dimensions of sustainability – economics, society, and environment. The four program objectives are:

1. Develop the data, models, and tools to expand community stakeholders' capabilities to consider the social, economic, and environmental impacts of decision alternatives on community well-being, and support the next generation of environmental scientists.
2. Develop the causal relationships between human well-being and environmental conditions and the tools and metrics that allow assessment and tracking of progress.
3. Provide research and technical support for cleaning up communities, ground water, and oil spills; restoring habitats and revitalizing communities; and advancing sustainable waste and materials management.

4. Develop a Sustainability Assessment and Management Toolbox to help the Agency and others build sustainability into day-to-day operations.

Introduction

Environmental Protection Agency (EPA) scientists and engineers and their partners are addressing 21st century environmental challenges by integrating research on environmental, economic, and social factors to provide sustainable solutions that support the Agency's mission to protect human health and the environment and advance the goals and cross-Agency priorities identified in the *FY 2014–2018 EPA Strategic Plan* (EPA Strategic Plan).

To assist the Agency in meeting its mission and priorities, the Office of Research and Development's (ORD) Sustainable and Healthy Communities (SHC) research program developed this *Strategic Research Action Plan, 2016–2019* (StRAP).

The SHC StRAP is one of six research plans, one for each of EPA's national research programs in ORD. The six research programs are:

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

EPA's six strategic research action plans are designed to guide a comprehensive research portfolio that delivers the science and engineering solutions the Agency needs to meet its goals and objectives, while also cultivating a new paradigm for efficient, innovative, and responsive government and government-sponsored environmental and human health research. The *SHC StRAP for 2016-2019* outlines the research approaches designed to achieve the goals and strategies set forth in EPA's Strategic Plan. It highlights how the SHC research program integrates efforts with other research programs across ORD, with EPA program and regional office partners, and external stakeholders to provide a seamless and efficient overall research portfolio aligned around the central and unifying concept of sustainability.

Environmental Problems and Program Purpose

While EPA has made significant progress in environmental protection in the United States during the past few decades, many challenges remain, and some communities are disproportionately impacted. Every day, communities face challenges with environmental implications, such as the following:

- Management of municipal and hazardous waste
- Health impacts from environmental contamination
- Increased stormwater runoff and flooding

- Loss of green space and ecosystem functions
- Increased greenhouse gas emissions
- Remediation of contaminated sites
- Siting of schools and public facilities
- Planning for roads and mass transit

Science to support sustainable decision-making is needed because the sum total of community-level decisions has broad implications for the environment, economy, and society. The tradeoffs across these dimensions, attendant in decisions about infrastructure, land use, and transportation, are often not well understood. There is often little information available on the impacts of such decisions on human health, ecosystems, local economies, and disproportionate environmental burden. Further, even when there may be information, it is not always accessible in a useful format for communities.

In addition, many communities still struggle with a legacy of contaminated land. We need better science to reduce risks from contaminated sites and ground water, develop less costly methods for remediation, and advance beyond remediation to restoration and revitalization of communities. While we have learned a great deal about safer management of wastes, we still need more options for eliminating waste, safer options for disposal of unavoidable wastes, methods to recover materials and energy from waste, and more options for re-use of materials.

The earth provides a vast array of resources that humans rely on: clean air, clean water, food, energy and others. While some of these resources, such as timber or fisheries, have a clear monetary value, the value of many other natural resources, such as wetlands, which help purify water and provide flood control, is harder to quantify. There are a whole host of resources like wetlands that provide important goods and services to people, yet we often don't realize and thus adequately value the services that such natural resources provide. Only recently have scientists begun to better document and measure these resources – known as ecosystem goods and services, or nature's benefits. This information is vital to making decisions that are sustainable for communities, economies, and the environment.

The *EPA FY 2014-2018 Strategic Plan* embraces “working towards a sustainable future” as a key cross-cutting strategy. EPA relies on the National Environmental Policy Act of 1969 (NEPA) definition of sustainability: The national goal of achieving “conditions under which humans and nature can exist in productive harmony and fulfill the social, economic and other requirements of present and future generations” (National Environmental Policy Act of 1969).

With sufficient knowledge and tools, urban, suburban and rural communities can develop in ways that improve the environment, human health, and quality of life of their residents.¹

¹ For more information about the impact of the built environment on the natural environment and public health, see “Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality” (2nd edition, 2013) at <http://www.epa.gov/smartgrowth/built.htm>.

Communities can make environmental decisions in ways that also strengthen the economy, adapt to a changing climate, improve resiliency to disasters, use public resources more efficiently, revitalize neighborhoods, and improve access to jobs and amenities.²

EPA defines the following principles³ to integrate sustainability into the Agency's day-to-day operations:

1. Conserve, protect, restore and improve the supply and quality of natural resources and environmental media (energy, water, materials, ecosystems, land and air) over the long term;
2. Align and integrate programs, tools, incentives, and indicators to achieve as many positive outcomes as possible in environmental, economic, and social systems; and,
3. Consider the full life cycles of multiple natural resources, processes, and pollutants in order to prevent pollution, reduce waste, and create a sustainable future.

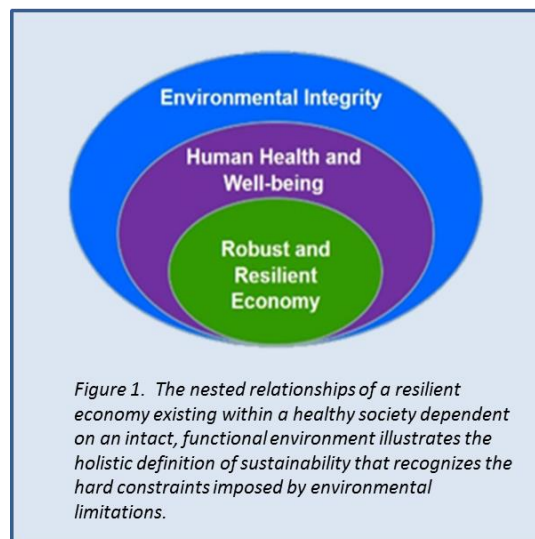
Emphasizing these principles, EPA is working to support states, local governments and communities in making sustainable environmental decisions. SHC research is developing the science needed to support such decision-making.

Problem Statement

Communities make decisions every day that either directly or indirectly affect the environment, public health, and well-being. These decisions can include the siting of roads, building schools, zoning decisions, and many others. For some decisions, the environmental, health and well-being impacts (beneficial or adverse) are not well understood and are rarely evaluated from a systems or holistic perspective.

Program Vision

SHC's objective is to provide a better understanding of the associations and causal relationships between public health, well-being, and ecosystem goods and services. SHC is developing the underlying research and tools to offer solutions to community-based decision-makers within and outside the Agency. SHC is committed to providing communities access to high-quality information and tools to help them evaluate the health and environmental impacts of alternative development choices and optimize decisions across the three dimensions of sustainability – economic, social, and environmental (Figure 1).



² Fiscal Year 2014-2018 EPA Strategic Plan http://www2.epa.gov/sites/production/files/2014-04/documents/epa_strategic_plan_fy14-18.pdf

³ *Ibid.*

As EPA employs regulatory and enforcement approaches to environmental protection, it also recognizes the need to promote concepts of sustainability and stewardship to reduce environmental risk and to promote health, economic vitality, and high environmental quality. SHC's vision is to develop the science to support EPA's approach to a sustainable environment and to expand community stakeholders' capabilities to consider impacts of decision alternatives (see Box, "SHC's perspective on Sustainability").

SHC's Perspective on Sustainability

The depletion of resources through the tragedy of the commons is an economic theory by Garrett Hardin¹, and is often cited in connection with sustainable development, meshing economic growth and environmental protection resulting in improved well-being. Commons in this sense has come to mean nature's benefits such as the atmosphere, oceans, rivers, fisheries; i.e., ecosystem goods and services. SHC subscribes to the view of Elinor Ostrom² who found the tragedy of the commons not as difficult to solve. She looked at how communities manage common resources, such as fisheries, land, water, air, and identified a number of factors conducive to successful sustainable management. All of these factors tend to operate as a holistic system with appropriate community-based rules and procedures in place with built-in incentives for responsible use and consequences for overuse.

SHC's research program is intended to understand the science of sustainable development and to develop tools that allow communities to avert the tragedy of the commons by using these tools to make informed decisions leading to improved well-being.

¹ The Tragedy of the Commons". *Science* **162** (3859): 1243–1248.

² Ostrom, E. (2009). "A General Framework for Analyzing Sustainability of Social-Ecological Systems". *Science* **325** (5939): 419–422.

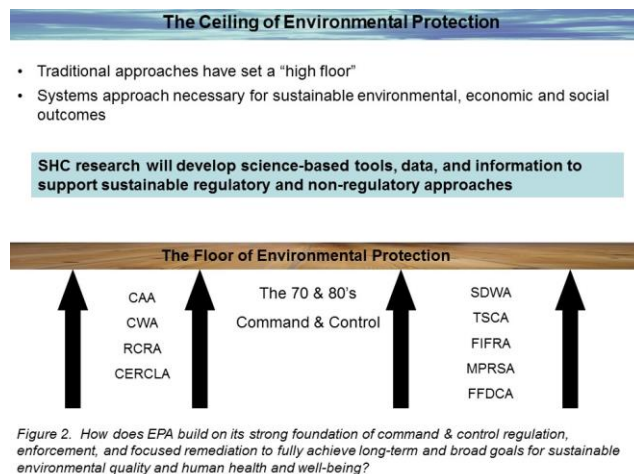
Program Design

EPA is pursuing a cross-Agency strategy to advance optimized, sustainable environmental, economic and social/health outcomes through Agency decisions and actions, recognizing that the Agency's traditional approaches to risk reduction and pollution control cannot always fully achieve broad, long-term environmental quality and human health and well-being goals⁴ (Figure 2).

Reaching these goals will require science and focused innovation to support solutions that will advance

sustainable outcomes that:

- recognize that while many environmental problems are global, national, and regional in nature, their impacts are experienced most acutely at the community level – like increased flooding, heat stress, contaminated water supplies, and poor air quality;
- foster and sustain community and individual health and well-being by providing research, tools and approaches that acknowledge the interconnectedness of the human-



⁴ Fiscal Year 2014-2018 EPA Strategic Plan; http://www2.epa.gov/sites/production/files/2014-04/documents/epa_strategic_plan_fy14-18.pdf.

ecological system, and the importance of a healthy environment to promote human health, economic resilience and social connectivity;

- address the challenges that still remain for communities with contaminated sites or that are at risk of environmental health disparities; and
- consider the life cycle and beneficial uses of materials in current manufacturing, construction, and waste streams to promote sustainable materials management.

The Sustainable and Healthy Communities research program is designed to provide science and technology to move the EPA toward these outcomes. The SHC program is organized around four research topics: (1) Decision-support and Innovation; (2) Community Well-being: Public Health and Ecosystem Goods and Services; (3) Sustainable Approaches for Contaminated Sites and Material Management; and (4) Integrated Solutions for Sustainable Communities. SHC includes research and development responsive to EPA's strategic goals and legislative mandates while at the same time implementing key recommendations of the National Research Council (NRC), particularly from its reports *Sustainability and the U.S. EPA* (the "Green Book")⁵ and *Sustainability for the Nation*⁶. SHC emphasizes systems approaches to identify and assess alternative approaches to more efficiently meet statutory mandates.

Building on the 2012-2016 Program

SHC is rooted in ORD's traditional research strength in human health, ecosystems and ecosystem services, site characterization and remediation for contaminated sites, and materials management (Figure 3).

Since its inception, SHC has built the foundation for integrating these previously disparate research areas into a coherent research program, and continues to do so moving forward. The

The NRC "Green Book" recommends that human health is explicitly included in the "social" drivers and metrics of sustainability. Health has been part of SHC from its inception and continues to be a critical factor in the development of indices, the linking of ecosystem services to their beneficiaries, and a focus on the health and well-being of vulnerable groups and lifestyles.

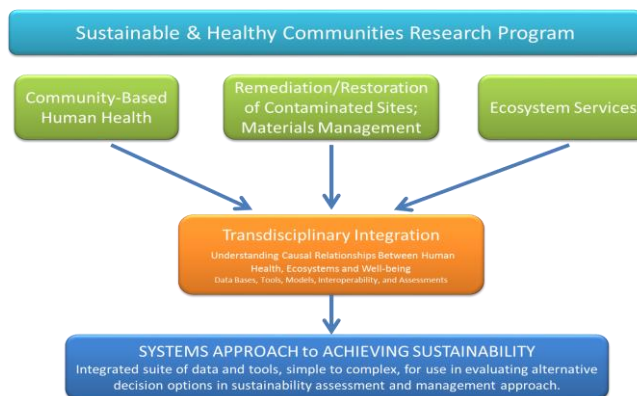


Figure 3. Roots of the SHC research and development program and redirection of separate human health, contaminated sites, and ecosystem services approach toward integrated approaches for

⁵ NRC, 2011. *Sustainability and the U.S. EPA* ("Green Book"). Washington DC: National Academies Press

⁶ NRC, 2013. *Sustainability for the Nation*. Washington DC: National Academies Press

FY16-19 program brings this expertise to bear on community-based issues by placing environmental science in the context of a decision-making framework, as recommended by the NRC^{7,8}. Structured decision-making has been called common sense for complex decisions. It provides SHC with a framework for applying its science to the multiple steps that facilitate making effective, defensible, transparent decisions. It also allows SHC to cast the NRC recommendation for building a Sustainability Assessment and Management Toolbox in the context of decision support (Figure 4). This framework enables scientific analysis driven by stakeholders that is transparent and flexible to different circumstances.

In particular, SHC will draw from its own research, the research of ORD's other National Research Programs, EPA tools and databases, other agencies, and the scientific community, to help develop a suite of tools that have the ability to analyze present and future consequences of alternative decision options on the full range of social, health, environmental, and economic indicators, as depicted in Figure 4.

In practice this means that, for example, ORD's fundamental research and long experience in supporting risk management alternatives can be brought to bear and expanded upon through an exploration of linkages in the Scoping and Options stage as shown in Figure 4. Various methods, metrics, models, or databases can be applied to a sustainability assessment to understand the implications of alternative decision scenarios that are relevant to the decision-makers' objectives. Market and non-market valuation of ecosystem services, the cost of illness and benefit of health promotion, and analyses of remediation options can apply to trade-off analyses. Finally, indicators and indices drawn from SHC's database, developed by the program or devised elsewhere can be applied to the monitoring and evaluation of outcomes of decisions to allow for the identification of best practices or the revisiting of decisions as needed (Figure 4).

⁷ NRC, 2013. Sustainability for the Nation. Washington DC: National Academies Press

⁸ NRC, 2011. Sustainability and the U.S. EPA ("Green Book"). Washington DC: National Academies Press

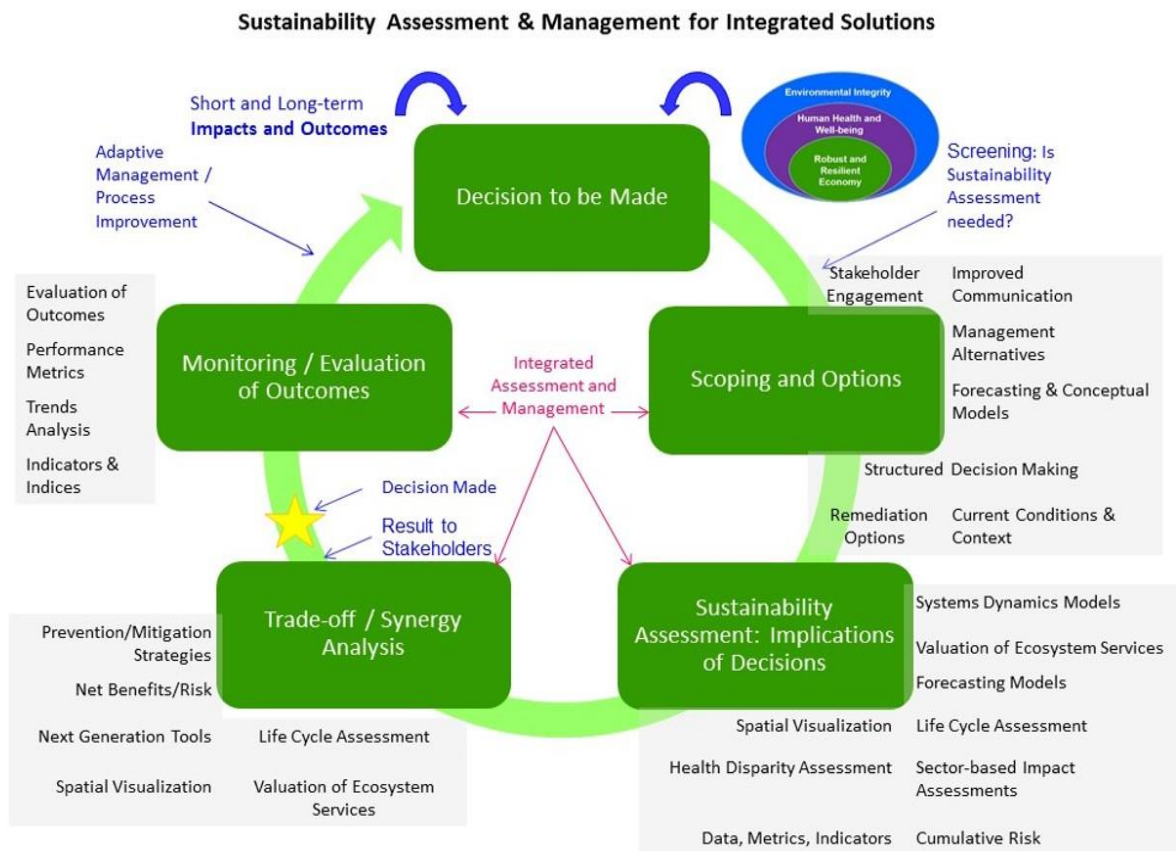


Figure 4. Sustainability assessment and management cycle for integrated solutions. Adapted from Figure 4-1 in the NAS “Green Book,” SHC proposes to use this cycle in case studies to support community decisions and to identify how and where in this cycle ORD and EPA research, data, models, tools, and experience can best be used for decision support.

Operationally, SHC considers well-being to be the endpoint for sustainability. Well-being is defined broadly and includes human health and safety, continued access to the benefits provided by ecosystem services, and economic security and resilience, now and in the future. It is important to consider the dynamic nature of the integrated environmental-economic-social system. Assessments of sustainability will incorporate projected changes in demographics, technology, ecosystem dynamics including climate change, values and changing social priorities, as well as emerging issues. SHC’s Sustainability Assessment and Management Toolbox will be flexible enough to address these changes as well as to support the varied nature of community stakeholders who make decisions under different contexts and with differing levels of capacity.

EPA Partner and Stakeholder Involvement

For the FY16-FY19 Strategic Plan, program and regional office managers and staff have been engaged in all stages of research planning. SHC meets regularly with EPA program and regional offices (Figure 5) to provide research updates, collect information on partner research needs, and discuss ORD’s response to these needs. This includes monthly cross-Agency meetings and

focused meetings on topics of particular interest with EPA partners, including the Office of Solid Waste and Emergency Response, Office of Air and Radiation and regional offices, and a major annual or biannual face-to-face research update and discussion.

Coordination with EPA program and regional partners is an important component of the SHC program. Some elements of the SHC program directly support EPA program partners and, thus, necessitate coordination through all stages of the research development process. Other elements are designated primarily to support community decision-making and can intersect with the activities of EPA program and regional partners, who, through their regulatory and implementation support activities, are also directly engaged in supporting community decision-making. This intersection presents opportunities for both ORD and EPA program and regional partners to work together to leverage and complement each other's efforts as they work to support communities. The result of such coordination is not only improved overall support for communities, but in many cases, the identification and design of research with dual benefits, supporting both community and EPA program and regional needs.

As part of our research program, SHC directly funds regional partners in collaborations through the Regional Sustainability and Environmental Science (RESES) Program to support transdisciplinary development of SHC's research and tools while addressing high-priority regional needs. ORD also collaborates closely with the regional offices through the Regional Applied Research Efforts (RARE) program on projects across the six National Research Programs.

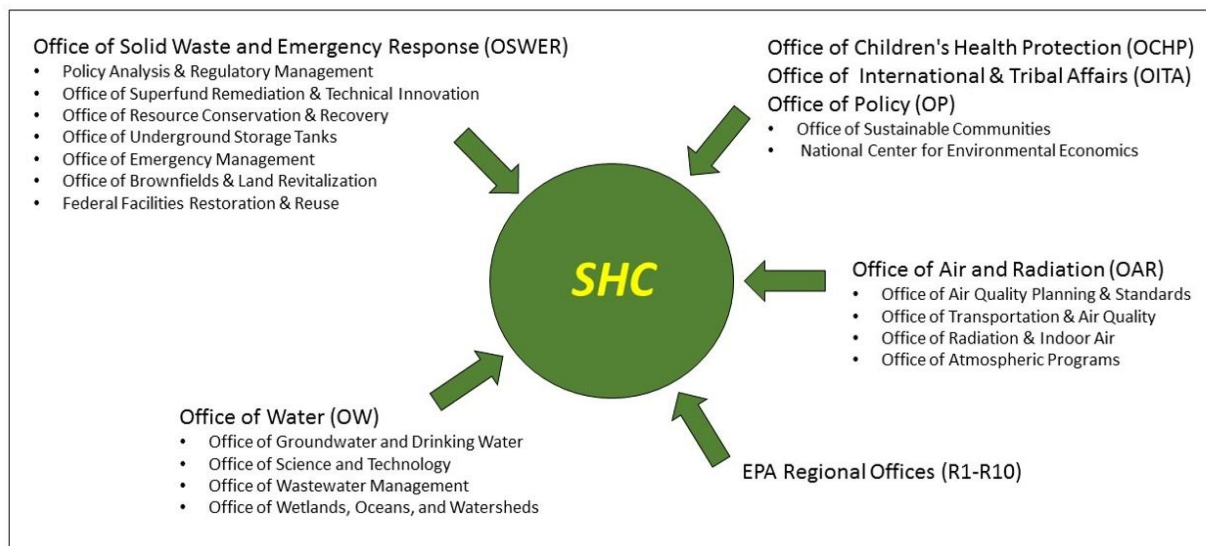


Figure 5. SHC Agency Partners. SHC engages EPA's statutorily derived Program Offices, all 10 regional offices, and other program offices.

In addition, SHC views states, tribes, and local governments as key stakeholders because of their role in making planning decisions that affect their communities. Stakeholder engagement,

including community stakeholders, in coordination with program and regional partners, is essential for SHC research going forward, recognizing that policy and planning decisions contributing to sustainable communities are not fundamentally technical with some need for public input, but, rather, fundamentally public with the need for technical input⁹.

SHC meets with key leaders of community-representative, sustainability-related organizations (e.g., ICLEI – Local Governments for Sustainability, Urban Land Institute and the Health Impact Project) at scientific and professional meetings. Together, with the EPA’s Office of Sustainable Communities, these organizations provide critical insights into the kind of community-level actions that need additional information or assistance to better foster sustainability.

Finally, SHC scientists are fully engaged with their scientific peers in colleges and universities and other Federal, state, local, and international agencies through formal and informal collaborations, professional societies, and through participation of scientists external to the EPA in SHC’s regular seminar series.

Integration Across the Research Programs

EPA’s six research programs work together to address science challenges that are important for more than one program. Coordination efforts can range from formal integration efforts across the programs at a high level to collaborative research among EPA scientists working on related issues.

To accomplish formal integration of research on significant cross-cutting issues, EPA developed several “Research Roadmaps” that identify both ongoing relevant research and also important science gaps that need to be filled. These roadmaps serve to coordinate research efforts and to provide input that helps shape the future research in each of the six programs.

SHC program products are incorporated across all of the roadmaps (Figure 6). For example, climate change impacts on ecosystem goods and services are assessed in research on ecosystem production functions, mapped in the EnviroAtlas and included in indices of community vulnerability. SHC is the lead National Research Program for Environmental Justice (EJ), reflecting the community/place-based nature of EJ concerns. The STAR¹⁰ Centers for Environmental Health Disparities and intramural research on community-based cumulative assessment and tribal science populate the Environmental Justice Roadmap (Project 2.3). SHC’s major investments in the EPA/NIEHS STAR Centers for Children’s Environmental Health (see Project 2.3, below) and grants on Healthy Schools are central to the *Children’s Environmental Health Roadmap*. Lastly, SHC provides a multi-sector, multimedia, systems approach to improving the management of nitrogen and co-pollutants.

⁹ Stave, K. Participatory system dynamics modeling for sustainable environmental management: observations from four cases. (2010). *Sustainability* (2): 2762-2784; Beierle, T. C. and Cayford, J. *Democracy in practice: public participation in environmental decisions*. Washington, DC: RFF Press 2002.

¹⁰ Science to Achieve Results (STAR) competitive grants are administered by EPA’s Office of Research and Development National center for Environmental Research.

ORD Roadmap	SHC Topic Area			
	Decision-support and Innovation	Community Well-Being: Public Health and Ecosystem Goods & Services	Contaminated Sites and Material Management	Integrated Solutions for Sustainable Communities
Climate Change	✓	✓ ✓	✓	✓
Environmental Justice	✓	✓ ✓	✓	✓
Children's Environmental Health		✓ ✓		
Nitrogen & Co-Pollutants	✓	✓		✓ ✓

Figure 6. Sustainable and Healthy Communities research program contributions to critical needs identified by ORD roadmaps. Checkmarks indicate a larger contribution of SHC activities and interest in the identified science gaps of the roadmaps than a single checkmark; a blank indicates no substantive role. SHC is the lead research program for ORD's Environmental Justice Roadmap.

Beyond the Roadmap topics, SHC integration with other National Research Programs includes:

1. CSS – Life cycle analysis for pre- and post-consumer-use materials management
2. SSWR – NetZero approaches; sustainable watershed management; green infrastructure decision support; ground water research
3. HSRP – Development of indicators for and spatial visualization of community resilience and vulnerability to climate change and severe weather; emergency response
4. ACE – Public health impacts of air pollutants to susceptible populations, especially asthmatics; development and application of air quality modeling tools; Influence of climate change on public health; planning tools for transportation networks and ports
5. HHRA – Cumulative risk assessment; health and ecology linked to well-being; technical support centers

Research to Support EPA's Strategic Plan

EPA's Strategic Plan advances optimized, sustainable environmental, economic and social/health outcomes through Agency decisions and actions, positing that the Agency's

traditional approaches to risk reduction and pollution control cannot always fully achieve broad, long-term environmental quality and human health and well-being goals¹¹.

Table 1 describes how SHC's actionable science primarily supports EPA's Strategic Goal 3 and the Agency's cross-cutting strategies of working toward a sustainable future and making a visible difference in communities. Because environmental impacts from all media affect communities, we note that SHC's research also informs EPA Goals with respect to Addressing Climate Change and Improving Air Quality and Protecting America's Waters. SHC is also committed to the research and development of tools that translate its science to move EPA toward its goal of Launching a New Era of State, Local, and International Partnerships.

¹¹ Fiscal Year 2014-2018 EPA Strategic Plan http://www2.epa.gov/sites/production/files/2014-04/documents/epa_strategic_plan_fy14-18.pdf

Table 1: SHC Alignment with EPA Fiscal Year 2014-2018 Strategic Plan

Strategic Goal	SHC Action
Goal 3 Cleaning Up Communities and Advancing Sustainable Development	Technical support and research to reduce risk from contaminated sites, build economic value through land restoration, address risks posed by accidental releases of hazardous materials and underground storage tanks, comprehensive protection of valuable ground water resources
	Research to develop more options for eliminating waste, safer options for disposal of unavoidable waste, management of electronics waste, and access to more options for beneficial re-use and recovery of materials and energy from waste
	Develop science-based tools to better engage citizens and inform local decision making to support smart and sustainable growth and equitable distribution of environmental benefits
	Research to adequately consider children's unique susceptibilities and vulnerabilities and to build capacity for implementation of sustainable environmental programs for tribes
EPA Cross-Cutting Strategy: Working Toward a Sustainable Future	Structured decision making approaches and science to advance sustainable environmental outcomes and optimize economic and social/health outcomes of decisions and actions that affect America's communities
	Science to build a systems understanding of the built and natural environments including their influences on human health and well-being to facilitate community sustainability and sustainable development
	A "sustainability toolbox" that includes a suite of tools for use in Sustainability Assessment and Management to move the Agency toward adoption of a comprehensive sustainability framework
EPA Cross-cutting Strategy: Working to Make a Visible Difference in Communities	Science supporting environmental justice: Integration of chemical and non-chemical stressors in assessment, social determinants of health and well-being, at-risk communities and lifestages, environmental health disparities; Health Impact Assessment; community-scale ecosystem services
	Research-based tools, indicators, and databases to provide relevant, robust, and transparent scientific data to support Agency, state, and local policy and decision-making needs to build healthy, sustainable, green neighborhoods, promote well-being, reduce and prevent harmful exposures and health risks to children and underserved, overburdened communities

Statutory and Policy Context

EPA's statutory and regulatory requirements have yielded a strong foundation of improved environmental quality. However, the Agency realizes that further progress can be made by working within and beyond its traditional approaches (see box below). SHC research and technical support is designed to assist the Agency to reach its immediate goals with respect to contaminated sites, environmental releases of oil, and sustainable materials management. SHC's program is also designed to help the Agency work toward its long-term and broader environmental quality goals by helping to identify and implement actions that satisfy its legislative, executive, and regulatory mandates while optimizing solutions to help move communities toward their sustainability and livability goals (Figure 7).

As mentioned above, EPA draws upon the National Environmental Policy Act (NEPA) for its broad definition of sustainability. NEPA also provides the statutory basis for the Environmental Assessment that will likely be a component of more fully integrated sustainability assessment approaches developed by SHC (Figure 4). SHC also recognizes the importance of the interplay between different environmental statutes for the multi-sector and multimedia issues facing communities.

SHC's community-based research addresses EPA responsibilities related to Superfund and CERCLA, RCRA, and the Brownfields Revitalization Act (Figure 7). Our ecosystem, health, and well-being research supports regulatory work carried out under these statutes as well as the Clean Air Act (e.g., NAAQS) and Clean Water Act. SHC is also responsible for research supporting the Oil Pollution Act of 1990, the Natural Resource Damage Assessment (NRDA), and the Resources and Ecosystem Sustainability, Tourism Opportunities, and Revived Economies of the Gulf Coast (RESTORE) Act. SHC research on children's environmental health, environmental health disparities, social determinants of environmental health, tribal science, and cumulative assessment are responsive to Executive Orders on children's health, tribal governance, and environmental justice (Figure 7).

EPA's Strategic Plan Cross-Agency Strategy:

Working Toward a Sustainable Future

Advance sustainable environmental outcomes and optimize economic and social outcomes through Agency decisions and actions, which include expanding the conversation on environmentalism and engaging a broad range of stakeholders.

...Our traditional approaches to risk reduction and pollution control cannot always fully achieve our long-term and broad environmental quality goals. The interplay between different environmental statutes and programs also requires renewed attention to improve "synergy" and long-term solutions. To this end, EPA will also embrace a commitment to focused innovation to support solutions that will advance sustainable outcomes.

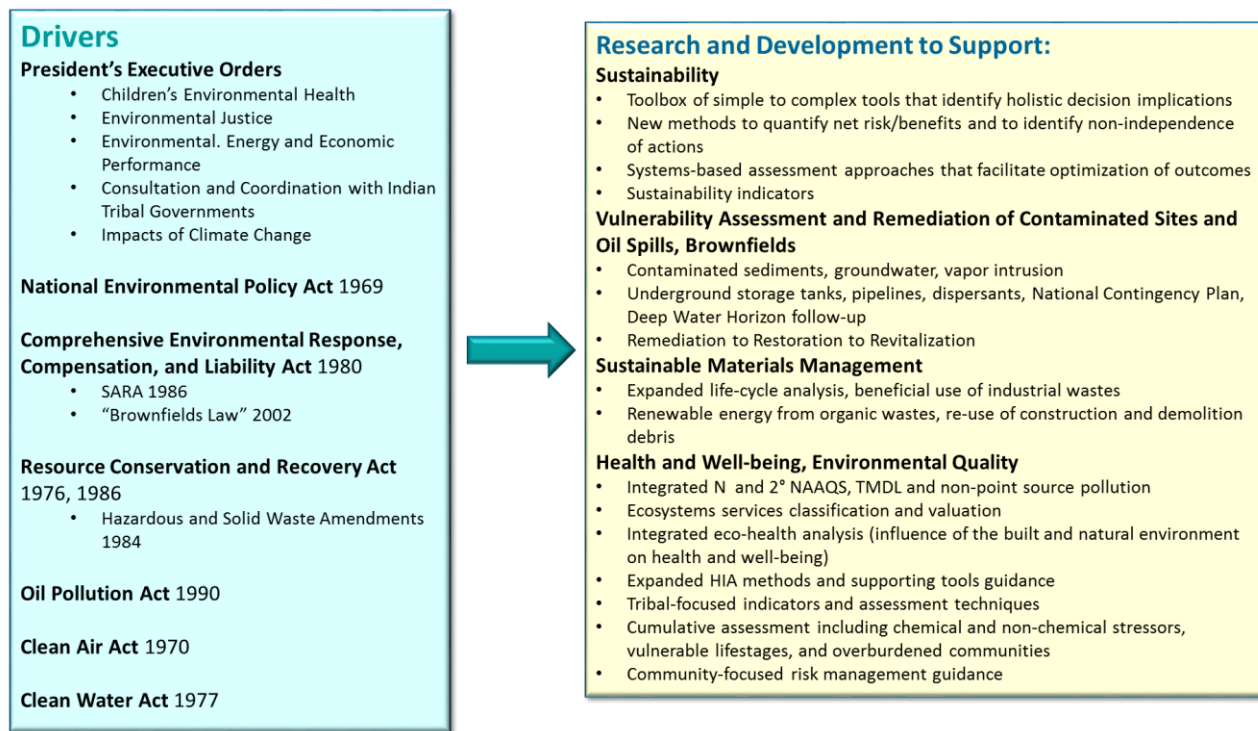


Figure 7. Sustainable and Healthy Communities research program is responsive to EPA's authorizing legislation and Executive Orders (left). Examples to the right illustrate the scope of SHC activities with respect to these drivers. (SARA: Superfund Amendment Reauthorization Act; HIA: Health Impact Assessment; NAAQS: National Ambient Air Quality Standards; TMDL: Total Maximum Daily Load)

Research Program Objectives

The SHC research program addresses four broad research objectives that flow from EPA's Strategic Plan, consultation with EPA program and regional partners, and ORD scientists' understanding of pressing science needs. These objectives are focused on addressing the environmental challenges identified above and aim to advance a more sustainable future.

Objective 1

Develop the data, models, and tools to expand community stakeholders' capabilities to consider the social, economic, and environmental impacts of decision alternatives on community well-being, and to support the next generation of environmental scientists.

SHC will assist decision-makers who affect community sustainability through the development of information, methods, and tools incorporating decision science, citizen science, spatial analysis, cause-effect modeling, and sustainability assessment. SHC tools will represent simple to complex approaches that can be used to frame decisions, increase community-engagement, fully account for decision implications, and identify potential solutions that promote a more sustainable future.

Science Challenges:

- Providing accessible science-based decision support to address the needs of the broad range of community sizes, capacities, demographics, and biophysical settings across the United States.
- Using community characterization, typology, and understanding about decision processes to tailor or guide assessment and decision tools to widely-shared or disparate needs.
- Harnessing new information technology, standards, and protocols to improve delivery and application of research results.
- Incorporating locally held and owned data into mapping tools, indicators, and indices to enable communities to compare among different areas thus allowing insights into where improvements are possible.
- Developing the next generation of environmental scientists to help solve the next generation of environmental problems.

Objective 2

Develop the causal relationships between human well-being and environmental conditions and the tools and metrics that allow assessment and tracking of progress.

SHC will provide science and metrics that inform the quantification, valuation and classification of ecosystem services, improve understanding of chemical and non-chemical determinants of public health and well-being, and allow assessment and tracking of changes. SHC will explore the dynamics of integrated human-ecological systems that identify implications of changes in both the built and natural environment on human well-being. SHC will also develop information and approaches that enable partners and stakeholders to better assess and predict the environmental, public health, and economic implications of decision alternatives, promote individual and community well-being with special attention to vulnerable groups and life stages, and track progress towards sustainability goals.

Science Challenges:

- Providing the science foundation for the relationship between the built and natural environments and human health and well-being.
- Developing indicators and indices that link environmental quality to community health and well-being, quantify changes and measure progress.
- Identifying the impact of social, economic, and environmental drivers on community public health, and providing tools to assist local decision-makers.

- Using case studies to assess environmental health disparities in vulnerable groups, including children, to provide decision-makers critical environmental public health information in future community decisions that affect sustainability.
- Improving the transferability of ecosystem series production functions from one location or scenario to others.
- Quantifying the impacts of social, economic and environmental drivers, particularly climate change impacts, on final ecosystem goods and services to improve community decision outcomes and promote sustainability.
- Identifying and integrating linkages between ecosystem goods and services and human health and well-being for use in risk, benefit-cost, or health impact assessments and community decisions.

Objective 3

Provide research and technical support for cleaning up communities, ground water, and oil spills, restoring habitats and revitalizing communities, and advancing sustainable waste and materials management.

SHC will provide the science needed to support Agency goals with respect to community public health, clean water, restoration and revitalization of contaminated sites, environmental releases, and better management of materials. This includes science to help partners and stakeholders to improve the efficiency and effectiveness of addressing contaminated sediments, land, and ground water, and resultant vapor intrusion. SHC research will also provide and evaluate standards, products, data, and approaches to prevent, characterize, and clean up environmental releases of petroleum and other fuel products. SHC methods, models, tools, and data will enhance sustainable materials management, including beneficial reuse.

Science Challenges:

- Developing and applying methods to assess contaminated sites and to measure the long- and short-term effectiveness of remediation and expediting the trajectory from remediation to restoration to revitalization.
- Identifying response products and actions that are effective on oil spills in a wide range of environmental settings to minimize environmental and human consequences.
- Identifying assessment and remediation approaches to minimize environmental damage and human and ecological exposures from leaking underground storage tanks.
- Application of life cycle analysis and sustainable materials management to resource use and recovery and energy efficiency.
- Optimizing material use reduction, reuse, recycling, disposal, and management to conserve and minimize contamination of land, minimize pollution emissions, and yield equitable co-benefits throughout a community.

Objective 4

Develop a Sustainability Assessment and Management Toolbox to help the Agency build sustainability into its day-to-day operations.

SHC will bring together research from both within SHC and external organizations to create a “Sustainability Toolbox.” These tools will provide a systems approach to help optimize actions that are based on a full accounting of the costs, benefits, tradeoffs, and synergies among social (including public health), economic, and environmental outcomes of alternative decisions.

Science Challenges:

- Building a systems-level understanding into an approach that supports decisions that have long-term, broad, and beneficial impact on community environmental quality, health and well-being, and economic resilience.
- Providing flexible, holistic decision-support tools that can be applied under varying decision contexts for decision-makers with different values and capacities.
- Analyzing present and future consequences of alternative decision options on the full range of social, environmental, and economic indicators.
- Showing distributional impacts of alternative options with particular reference to at-risk communities and ecosystems.

Research Topics

Each of the research program objectives identified above corresponds with one of SHC's research topics (Table 2).

Table 2. SHC Research Topics: Near- and long-term aims.

Research Topic	Near-Term	Long-Term
Decision-support and Innovation	Develop sustainability science; test and evaluate science and tools in communities; build the components necessary for integrated sustainability assessment and management that are most useful in a community context	Incorporate science and tools into the Sustainability Toolbox envisioned in Topic 4
Community Well-being: Public Health and Ecosystem Goods and Services	Link across final ecosystem goods and services classification systems and EnviroAtlas; enhance understanding of beneficiaries of ecosystem goods and services; understand modifiable factors and health interventions; provide indicators, indices and tools to assess, track, and inform community sustainability	Quantify and value ecosystem goods and services; integrate ecosystem goods and services with public health and well-being; develop and interpret robust indicators and indices of environmental performance
Sustainable Approaches for Contaminated Sites and Materials Management	Provide innovative research and technical support to address contaminated sites, sediments, and ground water; assess risks associated with the reuse of materials; provide EPA leadership on the National Response Team, develop and certify products for the National Contingency Plan	Understand how changing environmental conditions affect spatial and temporal variation of contamination; recast waste into resources; use life cycle analysis to inform the material-energy-water nexus; develop tools to map and inform communities about vulnerability to oil spills and fuel tank leaks
Integrated Solutions for Sustainable Communities	Build knowledge of buildings and infrastructure, land use, materials management, and transportation sectors into decision-support tools for sustainable outcomes; develop systems approaches for community decisions through case studies	Provide the data and tools to mainstream sustainability assessment and management

Topic 1: Decision support and innovation

Under this topic, SHC will develop the data, models, and tools to expand community stakeholders' capabilities to consider the social, economic, and environmental impacts of decision alternatives on community well-being. For example, tools will incorporate decision science techniques, spatial analysis, and sustainability assessment to help users frame decisions, increase community-engagement, understand implications of decisions, and identify potential solutions that promote a more sustainable future.

Project 1.1 Decision Science and Support Tools

While conceptually straightforward and intuitive, sustainability in practice is much harder to understand. This project aims to develop the science of sustainability and disseminate tools and methods for integrating sustainability approaches into EPA and community decision-making. Decisions that promote sustainable outcomes and minimize unintended consequences require access to relevant information, structured analytic approaches, tools for assessing and optimizing outcomes, examining trade-offs, and tracking progress. Through this project, we will improve our understanding of community decision needs, identify common characteristics of communities (i.e., community typology), improve the design and interoperability of sustainability tools, and partner with communities to develop and test decision support tools to promote the practice of sustainability.

SHC will approach its research objectives through 3 focus areas:

- 1) *Decision-focused Design and Use of Tools* – Understand local decision processes and patterns across communities to improve assessment and decision tools. Recognizing rapid changes in climate, demographics, and economies and create resilient and adaptive decision tools to meet changing community needs. Consider how digital tools can be used to engage communities in identifying sustainability challenges and regulatory compliance requirements and elicit stakeholder input for solving those challenges.
- 2) *Software Re-Configuration for Community-Based Use* - Evaluate how existing SHC tools can be modularized and made interoperable to increase their usefulness and reduce obsolescence. Consider how locally held data can be made accessible to inform decisions that promote sustainability and equity. For example, an interoperable component for storm water management using the EPA Storm Water Management Model (SWMM, developed by

Project Highlights

- Assessment of best practices in community-focused decision support tool design
- Report on emerging decision and computer sciences methods
- Inventory and searchable database of available community-focused decision support tools
- Gap analysis of community needs for sustainability assessment

SSWR) will be used to provide storm water runoff information within scenario planning tools such as Urban Footprint.

- 3) *Tool Development, Support, and Delivery* – Determine how new information technology can be harnessed to improve delivery of SHC tools to stakeholders in communities. Identify criteria and standards for future tool development to facilitate collaborative development of decision tools. Target development and updates of tools to fill gaps in decision-support needed for different types of communities to promote sustainability and well-being.

Products and their added value for the practice of sustainability will be demonstrated through case studies in conjunction with other SHC projects and related to ORD's four cross-cutting issues. This project will also likely rely on science developed in other ORD research programs to provide the technical information for local decision-makers. The case studies will integrate community preferred approaches and values along with science-based sustainability assessments.

Project 1.2 EnviroAtlas

The EnviroAtlas is a Web-based collection of tools and data resources that can be used to inform many different types of decisions. It allows users to explore the supply and demand of ecosystem goods and services, linkages to human health and well-being, and the distribution of stressors (e.g. pollutants and pollution) and other drivers of change (e.g. population change and demographics, land use). The EnviroAtlas includes national-scale coverage of these data, and also has a community component that includes fine-scale land use/land cover data to explore linkages between the built and natural environment and environmental and human health outcomes. The easy-to-use analysis tools makes this wealth of information broadly accessible to stakeholders and decision-makers at every level, providing the ability to incorporate systems-level understanding of decision implications on ecosystem services, human health and well-being, and economic resilience.

Three focus areas serve to organize the activities needed to achieve the research objectives:

- 1) *Improved Functionality and Case Studies* – Crosswalk ecosystem service indicators and indices from EnviroAtlas with the EPA Final Ecosystem Goods & Services-Classification System and the National Ecosystem Services Classification System (NESCS). Develop decision support case studies from real world applications of EnviroAtlas.

Project Highlights

- Land cover classification for additional communities
- Eco-Health Relationship Browser, version 2
- Nationally consistent geospatial indicators and indices
- Annual updates to EnviroAtlas application

- 2) *New Tools and Data Layers* - Enhance information for decision-making at local, state, regional, and national scales. Develop data for the community scale metrics and indices contained within EnviroAtlas to explicitly link features of the built and natural environment to community well-being. New analysis tools are under development that will provide user-defined indices to track progress towards sustainability goals, and to explore the implications of climate change scenarios in terms of heat stress, water availability, and energy use.
- 3) *Outreach and Communication* - Develop Web materials to inform decision-makers and educational and research users about how to use EnviroAtlas. Solicit feedback to inform future development.

Project 1.3 - Environmental Workforce and Innovation

EPA recognizes that STEM (scientific, technical, engineering and mathematical) competence is essential to the Nation's future well-being in terms of national security and competitive economic advantage. One aspect of community health and vitality is the availability of an adequate supply of scientists, technicians, engineers, and mathematicians, to develop innovative technologies and solutions for community application. With this in mind, SHC manages the Greater Research Opportunities (GRO) and Science to Achieve Results (STAR) Fellowships to help ensure there is a highly skilled pool of technical professionals that are trained to address society's pressing environmental issues. EPA's People, Prosperity and the Planet Program (P3), also managed by SHC, is an innovative student design competition for sustainability. Student teams designing tangible, cutting-edge solutions for communities to use to address environmental challenges. SHC also manages EPA's Small Business Innovation Research (SBIR) Program, which gives awards to small, high-tech companies to help develop and commercialize cutting-edge environmental technologies.

This project includes two focus areas:

- 1) *Fellowships* - The GRO Undergraduate and STAR Graduate Fellowship programs are part of the national effort to help ensure that the United States meets its current and projected human resource needs in the environmental science, engineering, and policy fields. The goals of the programs are to encourage promising students to obtain advanced degrees and pursue careers in an environmental field. These goals are consistent with the mission of EPA. Both programs have proven to be beneficial to the public by providing a steady stream of well-trained environmental specialists to meet society's environmental challenges. The most recent solicitation emphasizes a multidisciplinary background for candidates to encourage development of this type of curricula and contribute to the evolution of the environmental field.

Project Highlights

- Annual fellowship awards
- Small Business Innovative Research Phase I and II awards
- P3 awards

- 2) *People, Prosperity and the Planet (P3) and Small Business Innovation Research (SBIR)*: Increased awareness and understanding of sustainability are critical components for promoting a systematic shift towards more environmentally benign and sustainable products, processes, and systems. P3 and SBIR are programs that demonstrate sustainability values in the creation of design technologies and solutions to environmental problems. P3 and SBIR have provided incentive funding (1) to encourage sustainability thinking and research experiences for students and (2) to small businesses to translate their innovative ideas into commercial products that address environmental problems. These innovations are a source of new technologies that can provide improved environmental protection at lower cost with better performance and effectiveness. P3 and SBIR help spawn successful commercial ventures that not only improve our environment, but also create jobs, increase productivity and economic growth, and enhance the international competitiveness of the U.S. technology industry.

Topic 2: Community well-being: Public Health and Ecosystem Goods & Services

Topic 2 strives to develop the causal relationship between human well-being and environmental conditions as well as the tools and metrics that allow assessment and tracking of progress. For example, SHC research will provide the science that informs the quantification, valuation, and classification of ecosystem services, improve the understanding of chemical and non-chemical determinants of public health and well-being, and allow assessment and tracking of changes over time. SHC will explore the dynamics of integrated human-ecological systems and identify implications of changes in both the built and natural environment on human well-being, paying special attention to vulnerable groups and lifestyles.

Project 2.1 - Final Community-Based Ecosystem Goods and Services

EPA recognizes that too often, only what is quantified matters. However, many of the goods and services provided by the environment have not been measured; thus, they are not factored into decision-making in a robust and transparent way. This project aims to provide the knowledge and tools necessary to identify, quantify, and, ultimately, assign value to ecosystem goods and services. This will facilitate the incorporation of ecological benefits into decision-making processes.

Final Ecosystem Goods and Services (FEGS) are defined as components of nature, directly enjoyed, consumed, or used to yield human well-being

Specifically, this project includes five focus areas:

- 1) *Final Ecosystem Goods and Services (FEGS) Classification, Metrics and Production* – Includes quantifying the linkages between the supply of ecosystem goods and services and changes in human health and well-being (including intermediate and incremental changes and indirect human

health endpoints). Develop the EcoService Models Library to provide models to users to estimate benefits from ecosystem goods and services.

- 2) *Benefits of FEGS* – Identifies how FEGS are distributed among populations within a community, including vulnerable populations such as environmental justice communities. Quantifies benefits of ecosystem goods and services on human health endpoints. Couples FEGS with national economic accounting systems through collaboration with OW on the development of the National Ecosystems Services Classification System (NESCS).
- 3) *Climate/Stressors* – Quantifies the effects of climate change and co-occurring stressors on the benefits of FEGS, with particular attention to human health endpoints.
- 4) *Coordinated Case Studies* – Builds on the previous three areas to test whether concepts are transferable and scalable. Efforts will focus on existing conceptual relationships and move towards developing quantitative relationships among major stressors and drivers of change, FEGS, and consequent changes to human well-being.
- 5) *Integration, Synthesis and Strategic Communication* – Integrates and synthesizes research across focus areas and communicates results to EPA partners, the general public, and the scientific community. Assesses the transferability, scalability, applicability, and relevance of ecosystem service-related frameworks, models, methods (including community engagement), and tools that link the production of FEGS to human health and well-being.

Project Highlights

- Report on valuing community benefits of FEGS: economic benefits transfer methods and human health benefits
- Report on EcoService Models Library: structure, content and linkage to community-based decision-support tools
- Community metrics and indicators of FEGS
- Report on existing/needed ecological production functions to address climate change
- Report on lessons learned from SHC FEGS community-based studies

This project is of particular interest to program partners and includes SHC research to support the Nitrogen & Co-Pollutants Roadmap and the Climate Change Roadmap. There are also connections to research in ACE, SSWR, and HHRA linking health, ecosystems and well-being.

2.2 Community Public Health and Well-being

Community decision-makers make decisions every day that indirectly affect the environment, public health, and well-being (e.g., siting roads, building schools). In most community decisions, the environmental, health, and well-being impacts (beneficial or adverse) are not well understood or fully considered. This project aims to provide communities access to high-quality information and tools to help planners evaluate the health and environmental impacts of alternative development choices and optimize decisions across the three dimensions of sustainability – economic, social, and environmental. This project also seeks to provide a better understanding of the associations and causal relationships between public health, well-being, and ecosystem goods and services.

The research is organized into three focus areas:

- *Community engagement, assessment tools and decision-support tools*—Refine, develop, and enhance EPA information and tools to help communities and tribes identify and prioritize risks to inform local decisions. Tools include, for example:
 - Community-Focused Exposure and Risk Screening Tool (C-FERST) — an online information access and community mapping tool to help communities learn more about environmental, health, and socioeconomic issues in their community. It is designed to assist communities with the challenge of defining and prioritizing issues, and make decisions about exposures and risks within their community.
 - Tribal-Focused Environmental Risk and Sustainability Tool (T-FERST) – a Web-based information and mapping tool designed with tribes to provide easy access to the best available human health and ecological science.
 - Community Cumulative Assessment Tool (CCAT) – an educational tool that informs the public on the process of assessing cumulative impacts. It combines decision analysis and risk assessment to identify, evaluate, rank, and prioritize stressors and solutions.
 - Health Impact Assessment (HIA) – a process for evaluating the potential effects of a policy or program on the health of a population, and the distribution of those effects within the population. HIAs consider determinants of human health stemming from all of the three aspects of sustainability – social, environmental, and economic. For example, HIA takes into consideration factors such as employment, education, and climate change.
- *Environmental drivers of community health and well-being* - Understand how the conditions where people live give rise to various risk factors. Use population-based approaches to identify modifiable factors associated with increased environmental health risk combined with clinical and mechanistic studies. The goal is to improve risk assessment and enable communities and individuals to take action to protect themselves from environmental risks. Links between ecosystem goods and services and social and environmental modifiers (e.g., access to green space, food deserts, housing quality) will also be considered.

Project Highlights

- Public release of C-FERST and T-FERST
- Health Impact Assessment resource and tool compilation
- Report on the utilization of bioavailability methods to evaluate sustainable remediation technologies aimed to reduce community exposure to metals in soils
- Social determinants of environmental impacts on disease
- The impact of land use decisions on health outcomes
- Community vulnerability index
- Progress review summary report of the 2014 Cumulative Risk Assessment grants

- *Improving community health, well-being and exposure assessments* - Provide improved access to health and exposure data, inform and ground truth existing SHC tools, and explore innovative approaches to better understand and assess environmentally driven community health and well-being conditions. Develop rapid, reliable, and inexpensive methods for assessing the bioavailability of metals from contaminated soils and other exposure matrices to support the development of sustainable remediation technologies. Explore citizen science approaches, such as using sensors to inform communities about exposure and health conditions.

This project has aspects that will be coordinated with ORD's other research programs, specifically the environmental public health research in ACE, the cumulative risk assessment work in HHRA, and green infrastructure (GI) work in SSWR (e.g., GI implementation is the decision context for an HIA case study).

2.3 Assessing Environmental Health Disparities in Vulnerable Groups

There is growing recognition that environmental and social factors interact in complex ways to determine human health and well-being, and that optimizing environments for healthy and sustainable living requires an understanding of this complexity. This project focuses on how the built, natural, and social environments interact to influence health and well-being through all life stages. The overall project goal is to understand how non-chemical stressors (e.g., climate change, social factors) act as modifiers of chemical exposures and impact the health and well-being of vulnerable groups. Selected emphasis will be placed in three research focus areas:

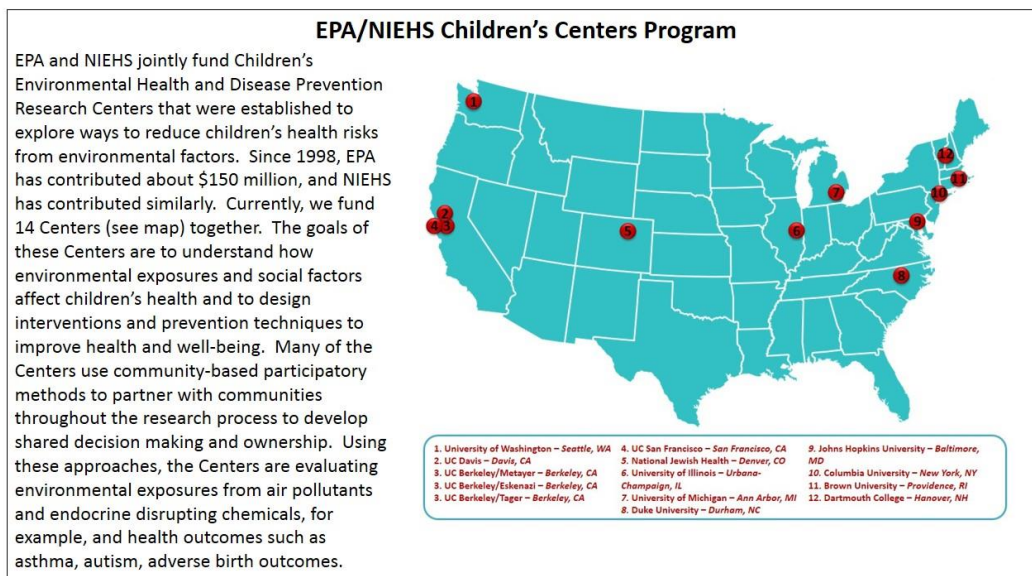
- 1) *Children's Environmental Health* - A complex array of environmental factors contribute to lifelong health and well-being. Among these are exposures to multiple manmade and naturally occurring substances which may occur both at critical windows of development and across the life course. This complexity calls for a systems approach to inform decisions designed to optimize our community environments (built, natural, social) for human health, especially for children, and environmental integrity. Intramural research complements the work underway in the EPA/National Institute of Environmental Health Sciences (NIEHS)

Children's Environmental Health and Disease Prevention Research Centers (Children's Centers) program (<http://www.epa.gov/ncer/childrenscenters/>). Research efforts in

Project Highlights

- The role of diet and obesity in determining bioaccessibility of organics absorbed into different types of soils and house dusts
- Interactions of chemical and non-chemical environmental stressors that impact children's healthy development and well-being
- EPA/NIEHS Children's Centers Program – 15 Years of Success
- Key findings and recommendations from the research of the Sustainable and Healthy Tribes grants
- Summary report for the research of the EPA/NIMHD Centers of Excellence on Environmental and Health Disparities Research

children's health are coordinated through the Children's Environmental Health Roadmap, and this project is SHC's contribution to that cross-cutting research.



- 2) *Tribal Communities* – EPA and the National Tribal Science Council have identified the need for evidence-based data and tools to help Tribes identify and anticipate potential environmental problems. This project will extend efforts from other SHC projects to tribal communities. For example, using participatory approaches, SHC and tribes can test tools (e.g., EnviroAtlas, Tribal-FERST, HIAs) and generate the local data needed to populate the tools and help tribal communities. The STAR Tribal Science Program will continue to contribute knowledge about tribal-specific environmental stressors (e.g., climate change, indoor air quality) as well as causal linkages to tribal health and well-being. EPA is also generating data (e.g., fish consumption, dietary exposure modeling) relevant to tribes to incorporate into SHC tools.
- 3) *Disproportionately Impacted Communities* - Environmental health disparities are a consequence of multiple factors contributing to vulnerability. This project will expand beyond disproportionate exposure to chemicals and their associated adverse health effects with the goal of understanding how environmental and social determinants (the conditions in which people are born, grow, live, work, and age) of health together can contribute to health inequities. These conditions are determined by community, governmental, and business decisions; education; and changes in local ecology. Specifically, this research aims to elucidate the relative contribution of these conditions and community stressors (e.g., behaviors, environmental factors, economic factors) in driving health disparities. The Centers for Excellence in Health Disparities are integrating environmental and social factors and testing approaches for reducing their negative impacts on health disparities. This topic area contains a significant portion of SHC's research related to environmental justice.

Project 2.4 - Indicators, Indices and the Report on the Environment

Lack of information on the environment, human health and well-being is a barrier to communities making more sustainable decisions. Indicators and indices (combinations of indicators) allow EPA partners and stakeholders to assess, track, and equitably weigh integrated human health, socio-economic, environmental, and ecological factors in their decision-making. This project will develop, evaluate, and advance the use of indicators and indices to help EPA and community stakeholders foster sustainability. This work is done in collaboration with the other ORD research programs, including with Homeland Security on climate resiliency indicators and HHRA on public health indicators.

The four focus areas include:

- (1) *State of the Practice for Sustainability Indicators* – Identify the current state of practice for environmental indicators in sustainability research and design research needed to fill information gaps. Specifically, this project will develop integrated compendia of indicators and indices to synthesize the state of the practice.
- (2) *Development of Indicators of Social, Ecological, and Community Resilience*- Advance the field of resilience science by exploring the interdependence of human and natural systems to inform integrated approaches for community sustainability planning and understanding potential trade-offs. Explore the linkages between sustainability, resilience, and environmental change and develop information on resilience to inform adaptive management of social-ecological systems, which is key to advancing sustainability.
- (3) *Interpreting environmental conditions in terms of ecological relevance, public health outcomes, and well-being endpoints* – Utilize holistic approaches for assessing human health and well-being in the interpretation of changes in environmental conditions over time. Evaluate the utility of indicators and indices that are used in SHC decision-support tools, such as DASEES, EnviroAtlas, and the Report on the Environment. Indicators and indices developed must address relevant data needs and be technically sound, easily understood, and accepted by stakeholders.
- (4) *Report on the Environment (ROE)* – Continue development and improvement of the ROE to meet changing programmatic needs, respond to new scientific information and incorporate new indicators. This project will (1) develop and maintain a scientifically refreshed and up to date ROE website; (2) develop new indicators in collaboration with EPA program offices; and (3) develop a new component piece to the ROE that analyzes and interprets the reported trends in a specific topic area.

Project Highlights

- State of the Science for Environmental Indicators
- Environmental Public Health Indicators Research Synthesis Report
- Development of a climate resilience screening index
- Modified Human Well-being Index models linking service flows to well-being endpoints
- Updated Environmental Quality Index with multiple geographic scales
- Updated Report on the Environment (RoE) with some analysis and interpretation of trends

Topic 3: Sustainable Approaches for Contaminated Sites and Materials Management

This topic provides research and technical support for cleaning up communities, ground water, and oil spills, restoring habitats and revitalizing communities, and advancing sustainable waste and materials management. Specifically, this work will help partners and stakeholders improve the efficiency and effectiveness of addressing contaminated sediments, land, and ground water and resultant vapor intrusion. SHC research will also provide and evaluate standards, products, data, and approaches to prevent, characterize, and clean up environmental releases of petroleum and other fuel products. SHC methods, models, tools, and data will enhance sustainable materials management.

Project 3.1 - Contaminated Sites

It is important to reduce or prevent human exposure to contaminants and to ensure that ground water quality meets drinking water standards. Contaminated ground water is found at most Superfund sites and cleanup can take decades to complete. Subsurface contamination can also be the source of volatile contaminants that enter residences or businesses, known as vapor intrusion, and expose individuals to hazardous pollutants. Discharge of contaminated ground water may increase contaminant loadings to sediments and to surface water.

This project will build on previous contaminated sites research and will involve the assessment of metrics for remediation, restoration, and revitalization in a context of potential spatial and temporal changes due to various factors, including climate change. The three focus areas of this project are:

- 1) *Technical Support for Contaminated Sites* - ORD will continue to provide valuable assistance to EPA programs to deal with contaminated sites and regional offices through five technical support centers, three of which are supported by SHC: Ground Water; Engineering; and Monitoring and Site Characterization.¹² Knowledge obtained through these activities provides the basis for designing future research.
- 2) *Research on Site Characterization, Remediation, and Management* – This area includes research on contaminated ground water and sediments and vapor intrusion.

Priorities for ground water research include: improving the application and interpretation of

Project Highlights

- Technical Support Center annual reports
- A decision-support system to guide the use of geophysical characterization and monitoring technologies for environmental investigations
- Report on flux-based site management
- Methods for testing freshwater sediment toxicity and bioaccumulation
- Spatial assessment of contaminated ground water at hazardous waste sites near vulnerable drinking water supplies

¹² The other two technical support centers, Superfund/Human Health and Ecological Risk Assessment Technical Support Centers, are supported by ORD's Human Health Risk Assessment (HHRA) research program, and there is coordination among all five centers across the two programs.

high resolution characterization technologies; characterizing sites and mitigating contamination via back diffusion; and developing and evaluating improvements in treatment delivery and extraction technologies and strategies to clean up contamination. Priority research for contaminated sediments includes: better understanding linkages between contaminant concentrations in sediment and fish tissue concentrations, improving analytical technology to evaluate hydrophobic organics and metals in soil and sediment, and evaluating the effectiveness of remediation alternatives and their associated impacts. Research on vapor intrusion will address the use of external remedial controls to reduce vapor intrusion and decrease the need for in-structure intrusive sample collection or in-building remediation systems.

- 3) *Research on Temporal and Spatial Impacts of Contaminated Ground Water - Site Reuse, Revitalization, and Environmental Justice* – the goals of this focus area are to understand the temporal and spatial changes in ground water, vapor intrusion and contaminated sediments in conjunction with social and economic factors related to community water supplies to address environmental justice concerns, Great Lakes Areas of Concern, and Brownfields needs. Research includes understanding aquifer vulnerability and private water well use, contaminant plume transport and its impact on public and private water supply wells, and social and economic factors which influence water use and water valuation.

Project 3.2 - Environmental Releases of Oils and Fuels

EPA is responsible for assessing environmental releases of oil from multiple sources, including fuel from leaking underground storage tanks. These releases occur in communities throughout the country and potentially affect human health and the environment through their impacts on water quality (including drinking water supplies) or direct exposure to toxic constituents. Innovative research approaches will help to achieve more efficient and effective management of oil spills, including fuel. This research supports development of improved protocols, guidelines, regulations, and response efforts to protect communities from exposures to environmental releases of oils and fuels. The private sector will use these protocols to advance remediation/response technologies for various conditions and oil products.

This project addresses impacts to community public health and ecosystems of oil spills and leaking underground storage tanks:

1) *Oil Spills* - Research will focus on two aspects of spill response: (1) spill preparedness via product testing protocols, and (2) innovative spill response options tailored to specific oils and environments, including sustainability dimensions of competing actions. This includes research to better understand the environmental impacts of oil spills (including non-petroleum oil) and dispersants as well as research to develop innovative and more sustainable technologies to assess and mitigate the impact of oil spills.

Project Highlights

- Report on development of a surface washing agent effectiveness protocol for products on the National Contingency Plan Schedule
- Report on the biodegradation and toxicity of diluted bitumen crude oils to determine fate of bitumen discharged in water
- Report on ethanol corrosion studies and ongoing technical support to states
- Report on density of domestic water well locations and proximity to leaking underground storage tanks and potential brownfields sites, through the use of GIS tools

2) *Leaking Underground Storage Tanks* - Research will focus on understanding emerging fuel compatibility with tanks as well as modeling and remediating contaminant plumes resulting from leaking underground tanks and their impacts on buildings and water supplies, both private and public. The research is intended to: (1) develop an improved conceptual model for plume formation and migration from petroleum hydrocarbons, ethanol, and other additives; (2) develop a better understanding of fuel behavior at the water table and impacts to water supply wells resulting from precipitation changes due to climate change; and (3) develop the capacity to identify areas with high density of private wells, potentially leaking tanks, redevelopment sites, and proximities to water supplies.

Project 3.3 - Sustainable Materials Management

The goal of this project is to enable partners and stakeholders to minimize environmental impacts associated with products and materials through reduced consumption and increased reuse and recycling. Specifically, the research will develop and demonstrate life cycle assessment paradigms and material, product, and process design strategies that lead to reduced environmental impacts while preserving natural capital. Greenhouse gas emissions will be an important aspect of this project as well.

This project includes three focus areas:

1) *Life Cycle Management of Materials* -

This focus area will consider both sustainable materials management and life cycle assessment (LCA) to develop an integrated framework to support decision-making. Other methodologies for community material management, such as urban metabolism¹³, will also be explored. This project will develop life cycle inventory data focused on end-of-life materials management processes (e.g., landfilling, recycling), which are existing data gaps and will help develop data for baseline modeling scenarios.

Data developed in this project will be openly available through an EPA portal to the Federal LCA data commons (add link). LCA work is done in coordination with related efforts in other programs, such as CSS.

2) *Reuse of Organics and Other Materials* - This focus area will develop dynamic approaches to assist communities in enhancing energy generation and materials recovery from existing waste streams or underutilized material flows. Reuse of materials (e.g. industrial, agricultural, and organic and inorganic sources) may offset the use of virgin materials in products or processes and potentially lead to reducing their adverse effects on the environment and human/ecosystem health. Included in this focus area is research in conjunction with the U.S. Army's Net Zero initiative. The Net Zero Initiative enables the Army to appropriately safeguard available resources and manage costs by reducing the generation of solid waste.

3) *Regulatory Support* - This focus area will provide technical support, primarily to OSWER on various aspects of sustainable materials management. We expect these issues to evolve over time. Examples of previous support focus on coal combustion residues, use of the leaching environmental assessment framework, and evaluation of empty pharmaceutical containers. Electronic waste is another important area for EPA under the National Strategy for Electronics Stewardship. There is a lack of coherent information on the domestic movement of used electronics, so SHC will address this need and, if possible, develop an online tracking tool.

Project Highlights

- Publically accessible EPA portal to the LCA commons installed on a linked open data (LOD) server
- Risk-Informed Materials Management tools system, technology transfer, and demonstration applications (e.g., reuse scenarios for biosolids)
- Comprehensive assessment of the flow of used electronics for selected states
- State of the practice for construction demolition and recycling
- Resiliency of waste containment systems to extreme weather events

¹³ Kennedy et al. 2007 define urban metabolism as "the sum total of the technical and socio-economic process that occur in cities, resulting in growth, production of energy and elimination of waste." Source: Kennedy, C., Cuddihy, J., and Engel-Yan, J. (2007). The changing metabolism of cities. *Journal of Industrial Ecology*. 11(2), 43-59.

Topic 4: Integrated Solutions for Sustainable Communities

The goal of Topic 4 is to help the Agency build sustainability into its day-to-day operations. SHC will provide community stakeholders with a suite of simple to complex tools that used together provide a systems approach to help them optimize actions that are based on a full accounting of the costs, benefits, tradeoffs, and synergies among social (including public health), economic, and environmental outcomes of alternative decisions. Specifically, SHC aims to develop a sustainability assessment and management toolbox for use by community stakeholders.

Project 4.1: Integrated Solutions for Sustainable Communities

This project aims to help partners and stakeholders consider the three dimensions of sustainability in their decision-making so that they can minimize unanticipated outcomes. It will bring together research from both within SHC and external organizations to create a “Sustainability Toolbox.” These tools will bring a multi-sector, cross-disciplinary, systems perspective to decision-making. This project will: (1) provide clear context-specific information to decision-makers on selection and use of tools and best practices, (2) improve, extend, and integrate tools and approaches for sustainability assessment, and (3) demonstrate both the use of a suite of complementary tools and the effectiveness of a holistic approach for resolving complex issues and advancing sustainability.

This project has three focus areas:

- 1) *Sustainability Toolbox* – Under this focus area, ORD is working with partners to develop a question-based interactive Web-based tool (commonly referred to as a “wizard”) to guide users to find the most pertinent information and tools to meet their needs. The initial wizard is focused on green infrastructure (drawing on research and tools developed in SSWR and across EPA). The next wizard is planned to focus on waste and materials management. This Community Sustainability Analysis System (CSAS), will help partners and stakeholders make decisions that will advance more sustainable outcomes.

Project Highlights

- Product waste and materials management online wizard
- Alternate management scenarios to inform urban sustainability assessment and management decisions
- Atlas of nitrogen and co-pollutant maps
- Interactive effects from climate changes and nitrogen loading on terrestrial and aquatic ecosystems
- Ports sustainability assessment toolkit

- 2) *Sustainability Assessment and Management (SAM) Process for Communities* - This work builds on SHC’s existing sector-based synthesis papers on land use, buildings and infrastructure, materials management and waste, and transportation. It will develop integrated approaches to enable communities to holistically evaluate decisions across these sectors. A SAM is defined as an approach that provides tools and information that a community can use to assess decision alternatives in a systems context, evaluate the

implications and tradeoffs across the sectors, and move toward more sustainable solutions. We anticipate developing a flexible approach that can be tailored to individual communities' needs.

- 3) *Case Studies* – This focus area includes applications of systems approaches for sustainability to real-world problems through demonstration projects. Integrated nitrogen management, ports, and community water management are three topics that will be addressed. These demonstrations will allow us to refine the sustainability assessment process and evaluate the effectiveness of systems-based decision-making and management practices that integrate social, environmental, and economic dimensions. The demonstrations will utilize, test, and evaluate existing sustainability tools; identify gaps in data and assessment capabilities; and increase our understanding of key relationships that can inform future sustainability assessments. The goal is that these case studies will be generalizable and transferable to other communities and move the science of sustainability assessment forward.

Anticipated Research Accomplishments and Projected Impacts

SHC research is building a better understanding of the associations and causal relationships between public health, well-being, and ecosystem goods and services. This research will have the greatest impact when products are developed and delivered in ways most useful to SHC partners and stakeholders. ORD products specifically designed to be useful in the hands of partners are termed “outputs.” The proposed SHC outputs for FY16 to FY19 are listed in Appendix A. Examples of anticipated accomplishments for each research topic area are summarized below.

Decision-support and Innovation

Research on decision support and innovation tool development will focus on the utility of the EnviroAtlas and development of next-generation tools and software to ensure sustainable and healthy communities. The anticipated accomplishments include the public release of a new EnviroAtlas section showing real-world use cases that demonstrate how to apply Atlas data to communities' common high priority decisions with respect to maintaining or promoting good environmental quality, environmental public health and well-being, and community-level preparation for adaptation to climate change. In addition, climate change implication tools and data layers will be incorporated into the EnviroAtlas, allowing the users to visualize the implications of climate change on community sustainability, such as changes in water supply, heat-related health impacts, and sea-level rise. These accomplishments will allow users to factor potential climate change impacts into decisions affecting community sustainability and community vulnerability. Finally, in addition to advances for the EnviroAtlas, SHC anticipates significant accomplishments in the development of new decision-support tools, enhancements to existing tools, and methods/components for the delivery of both new and existing tools that capitalize on existing reusable software and advances in information technology to ensure

interoperability while filling gaps in tools currently available to inform community decisions that promote sustainability.

Community Well-Being: Public Health and Ecosystem Goods & Services

Anticipated accomplishments for this research will provide a comprehensive source of scientific indicators that describe the trends in the nation's environmental and human health condition and will be included in the draft *Report on the Environment (ROE) 2017*. The indicators help to answer important questions about the current status and historical trends in U.S. air, water, land, human health and exposure, ecological systems, and sustainability at the national and regional levels. Much of the research in Community Well-Being will provide research findings that incorporate the impacts of social, economic and environmental drivers, particularly climate change impacts, on final ecosystem goods and services into community-level decision-support tools and the EnviroAtlas. In addition, research outputs will integrate ecosystem good and services, human health, and human well-being research results in order to assist communities and tribes in holistic decision-making. These integrated results that link human health and well-being to environmental stressors and features of the built and natural environment will improve our ability to communicate strategies for educating risk assessors, decision-makers, and the public on reducing childhood diseases and promoting healthy and sustainable community settings.

Sustainable Approaches for Contaminated Sites and Material Management

This topic area will continue the high level of public health/environmental research and technical support to the program and regional offices with a focus on methods for characterizing and remediating contaminated ground water, vapors, and sediments; tools for evaluating temporal and spatial impacts of fuels/oils site cleanup; and, tools for life cycle assessment and sustainable materials management. These accomplishments will provide an integrated approach to evaluate and mitigate subsurface contamination including contaminant fate and transport, to improve draft sediment testing methods for assessment of toxicity and to assess practical approaches to characterize and control vapor intrusion in buildings. Research to determine the type, degree, and extent of impacts of fuel and oils spills will provide tools to communities and site managers to better evaluate and predict the potential public health impacts of fuels and oils and better evaluate potential exposure to populations and impacts to ecosystem services that will affect human health and well-being. Anticipated accomplishments in this area will also provide tools to determine the temporal and spatial impacts of managing materials on community public health and their resources including: impacts to community drinking water quality and quantity from contaminated ground water; impacts to indoor air in homes and schools from contaminated ground water and soil gas from material management operations; and impacts to land from management operations.

Integrated Solutions for Sustainable Communities

Anticipated accomplishments for this research will include a user-friendly interactive Web-based sustainability toolbox that can be used by community stakeholders to identify critical

information and analytical tools to help them reach their sustainability goals. This toolbox, the Final Community Sustainability Analysis System, will facilitate planning that recasts waste as materials, optimizes energy efficiency and energy recovery, moves toward net zero water usage, and other steps toward community sustainability. For the toolbox, SHC will synthesize and evaluate sustainability assessment and management methods building on all previous SHC efforts (as well as methods developed by others outside of EPA), considering relevance, efficacy, and ease of use. The synthesis will provide communities and other decision-makers with the best available approaches for holistically evaluating common decision options and identify the ones that best foster community sustainability. Finally, the nitrogen research accomplishments will provide the framework, tools, and approaches to holistically evaluate the implications of nitrogen pollution and nitrogen management options (regulatory and non-regulatory), especially in the context of changing conditions, e.g., due to climate change. This research will allow those who affect or regulate nitrogen loading to make decisions that will better capture the positive benefits of nitrogen use, while preventing the negative impacts on human health, well-being, and ecosystems.

Conclusion

The EPA FY 2014-2018 Strategic Plan posits that the Agency's traditional approaches to risk reduction and pollution control cannot always fully address some long-term and broad environmental quality and human health and well-being issues. This is especially true at the community level, where repercussions of environmental problems, ranging from leaking underground storage tanks to climate change-exacerbated storms, are acutely felt, while the capacity and authority to identify and address causes vary widely. SHC's research has embraced the challenge of providing knowledge and tools that will help the variety of decision-makers at all levels of governance sustain the natural systems, well-being, and economies of their communities.

SHC research and development efforts will enable greater understanding of, for example, the relationship of the built, natural, and social environments to human health and well-being; the production, supply, beneficiaries, and valuation of ecosystem services; approaches to recast waste as resources; and the processes and remediation of contaminated sites and ground water. SHC research will also provide ways to measure and convey those relationships and processes. Most importantly, SHC will develop methods for using and communicating that information in structured decision processes that incorporate science and stakeholder values.

Community sustainability is often defined by the desire to meet today's needs without compromising the quality of life of future generations. SHC's program is designed to advance community sustainability by providing the science and tools to make informed choices that avoid unintended consequences while helping communities to seize opportunities to enhance health and well-being for present and future generations.

APPENDIX: Summary Table of Anticipated Outputs

Project Area	Area-Specific Outputs
Topic 1: Decision-support and Innovation	
Decision Science and Support Tools	<p>FY16 – Report on the design of software applications and decision processes for different types of communities</p> <p>FY17 – Methods to allow communities to calculate indicators and indices of sustainability and well-being using local data</p> <p>FY17 -- Demonstration of interoperability with a system of databases and tools integrating economic, environmental, and health and well-being endpoints.</p> <p>FY18 – Searchable library of available community decision-support tools and modules; software to help users identify and use appropriate tools for their needs</p> <p>FY19 -- Next generation decision-support tools that capitalize on existing reusable software and advances in information technology to ensure interoperability while filling gaps in tools currently available to inform community decisions that promote sustainability.</p>
EnviroAtlas: A Geospatial Analysis Tool	<p>FY16 -- Applications of EnviroAtlas to community-based decisions</p> <p>FY17 -- Crosswalk between ecosystem services mapped in the EnviroAtlas with those in the final ecosystem goods and services (FEGS) classification system</p> <p>FY17 -- Community metrics for EnviroAtlas</p> <p>FY17 -- Add data to EnviroAtlas to allow decision makers to understand impacts of sea level rise, severe weather, precipitation, water supply, and extreme heat on ecosystem goods and services</p> <p>FY18 -- Ecosystem services demand/benefit/beneficiaries data layers for EnviroAtlas</p>
Environmental Workforce and Innovation	<p>FY16 -- A synthesis of innovative ideas from the SBIR and P3 Programs</p>
Topic 2: Community Well-Being: Public Health and Ecosystem Goods and Services	
Community-Based Ecosystem Goods and Services	<p>FY16 – Ecosystems goods and services production and benefit functions case studies report</p> <p>FY17 – Practical strategies for assessing final ecosystem goods and services in community decision-making</p> <p>FY18 – Provide information about the impacts of human actions and environmental forces (particularly climate change) on final ecosystem goods and services (FEGS) for incorporation into community-level decision-support tools and the EnviroAtlas</p>

Project Area	Area-Specific Outputs
Community Public Health and Well-Being	<p>FY16 -- Demonstrations of applying tools, methods, and community engagement mitigate environmental health impacts in at-risk communities</p> <p>FY16 -- Methods for cumulative, integrated assessments of chemical and non-chemical stressors and pilot application of these assessments to reduce community environmental health risks and promote community health and well-being</p> <p>FY17 -- Synthesis of best practices learned from community participatory studies that address environmental health concerns within communities</p> <p>FY18 - A report on the state of the practice for integrating ecosystem good and services, human health and human well-being research for assisting communities in decision-making</p> <p>FY19 -- Enhanced community public health tools (e.g., C-FERST) providing access to information for identifying, prioritizing, and addressing environmental health issues in local decision-making</p>
Assessing Environmental Health Disparities in Vulnerable Groups	<p>FY16 -- Development of a systems-level approach to understanding children's environmental exposure, health, and environmental diseases in the natural and built environment</p> <p>FY16 -- Communication strategies for educating risk assessors, decision-makers, and the public on reducing childhood diseases and promoting healthy and sustainable community settings</p> <p>FY19 -- Translational research to incorporate data and information on childrens' environmental health into tools to inform community actions</p> <p>FY19 -- Research to inform tribal sustainability decisions</p> <p>FY19 -- Evaluation of tested approaches to resolving health disparities in vulnerable populations and lifestages.</p>
Indicators, Indices, and the Report on the Environment	<p>FY16 -- Report on the State of the Practice for Environmental Indicators: 2012-2015</p> <p>FY17 -- Provide indicator information necessary for the incorporation of environmental indicators into SHC decision-support tools</p> <p>FY18 -- Draft report on the Environment (ROE) -2018 with interpretation of trends</p> <p>FY19 -- Report on the State of the Practice for Environmental Indicators: 2016-2018</p>
Topic 3: Sustainable Approaches for Contaminated Sites and Material Management	
Contaminated Sites	<p>FY16 -- Methods for characterizing and remediating contaminated ground water, vapor, and sediments sites, that have single or multiple containments, to improve community public health and their resources and facilitate revitalization</p> <p>FY17 -- Strategies for integrated assessment and remediation of contaminated sites</p> <p>FY17 -- Tools for evaluating temporal and spatial impacts of contaminated sites on public health and the environment, for use in site remediation, restoration, and revitalization decisions</p> <p>FY18 -- Incremental report on lessons learned from ORD's Technical Support to Superfund and other contaminated sites</p>

Project Area	Area-Specific Outputs
Environmental Releases of Oil and Fuels	<p>FY16 – Tools for improved characterization, response and remediation of oil and fuels to improve emergency response and other clean-up activities</p> <p>FY17 – Tools for evaluating temporal and spatial impacts of fuels/oils site cleanup on public health and the environment, for use in site remediation, restoration, and revitalization</p>
Sustainable Management of Materials to Support Community Sustainability	<p>FY17 - Sustainable materials management options for industrial, construction/demolition, and municipal materials including reduction, reuse, and recycling/repurposing to protect community public health and the environment</p> <p>FY18 – Strategy for sustainable materials management</p> <p>FY18 -- Tools for evaluating temporal and spatial impacts of materials management on public health and the environment, for use in restoration and revitalization decision-making</p>
Topic 4: Integrated Solutions for Sustainable Communities	
Integrated Solutions for Sustainable Communities	<p>FY18 -- Sector-based information and decision tools (including sustainability assessment) for pursuing community sustainability in land use, transportation, buildings and infrastructure, and waste and materials management sectors</p> <p>FY19 -- Tools to inform regulatory and non-regulatory solutions to nitrogen pollution through the consideration of impacts/effects on ecosystem services</p> <p>FY19 – Expanded Community Sustainability Analysis System (CSAS) Web-based information portal</p> <p>FY19 - Approaches for integrated sustainability assessment and management to proactively inform community decisions and advance sustainability</p>