# Compiled SHC Project Charters

Revised November 17, 2014

## Note to BOSC:
## The research will evolve from what is reflected in these charters.

Contents


**1.61** Decision Science and Support Tools ..... 2
**1.62** EnviroAtlas ..... 10
**1.63** Environmental Workforce and Innovation ..... 23
**2.61** Final Community-Based Ecosystem Goods and Services ..... 28
**2.62** Community Public Health & Well-being ..... 40
**2.63** Assessing Environmental Health Disparities in Vulnerable Groups ..... 50
**2.64** Indicators, Indices and the Report on the Environment ..... 58
**3.61** Contaminated Sites ..... 71
**3.62** Environmental Releases of Oils and Fuels ..... 84
**3.63** Sustainable Materials Management ..... 91
**4.61** Integrated Solutions for Sustainable Communities ..... 101

# 1.61 Decision Science and Support Tools

**Project Number & Title**
1.61 - Decision Science and Support Tools

**Project Lead and Deputy**
Project Lead: Brian Dyson, NRMRL
Deputy Project Lead: Allen Brookes, NHEERL

**Project Period**
FY16-FY19

**Project Summary**
This project will provide communities and other community-relevant decision makers with access to decision support approaches and tools to better frame their environmental problems and decision contexts, facilitating sustainable outcome 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. Helping communities contribute information and develop their understanding of sustainability will assist stakeholders in solving social, economic, and environmental issues.

Work in this project has four primary aims:
(1) Improving our understanding of community decision needs and objectives to support user oriented tool design;
(2) Informing sustainable outcomes through tools that structure community defined decision-focused processes;
(3) Developing generalizable tools emphasizing interoperability, system-level understanding, and adaptability to user preferences, capacity, and informational resources of communities;
(4) Providing accessibility to tools identified through decision contexts, community typologies, and needs-based gap analyses.

Product usability will be demonstrated in conjunction with other related Sustainable and Healthy Communities (SHC) projects (e.g., Project 2.62 Community Public Health and Well-Being and Project 4.6 Systems-based Methods for Community Sustainability) through the continued development of case study applications of decision-making methods that integrate community preferred approaches and values along with science-based sustainability assessments.

**Project Description**

<u>Problem and Decision Context</u>

The over-arching research question for SHC can be stated as: How does the EPA help achieve more sustainable outcomes in all types of communities, ranging in size, demographics,

locations, and resilience capacity. Research and development in this project seeks to address this question by developing tools and application approaches informed by decision science for those engaged in helping communities advance sustainability goals and reduce the risk of regulatory non-compliance. This will be done through identifying community user decision needs and translate those into the development of generalizable methodologies for the identification, creation, re-use, distribution, and application of resultant tools to communities. An important part of achieving our goals is to identify internal and external organizations, e.g. Office of Solid Waste and Emergency Response; the Rockefeller 100 Resilient Cities Program, that are working in the same areas and find ways to complement their work in order to achieve the best results in the most efficient way.

Outputs

This project will directly contribute to five SHC outputs.
1.61.1 Guidance to Support the Design of Software Applications and Decision Processes for Different Types of Communities (Initial version FY16)
1.61.2 Methods to allow communities to calculate indicators and indices of sustainability and well-being using local data (FY17)
1.61.5 Demonstration of interoperability with a system of databases and tools integrating Economic, Environmental, and Health and Well-being endpoints (FY17)
1.61.3 Searchable Library of Available Community Decision Support Tools and Modules; Software to Help Users Identify and Use Appropriate Tools for Their Needs (FY18)
1.61.4 Next-generation decision support tools that capitalize on existing re-useable software and advances in information technology to ensure interoperability while filling gaps in tools currently available to inform community decisions that promote sustainability (FY19)

Focus Areas

*Focus Area #1: Decision-focused Design and Use of Tools* – Integrating current and future knowledge of group/organizational decision-making, community typology, and user decision needs into the design, identification, and application of tools by communities.

Representative questions:

- How can community characterization, typology, ecosystem beneficiaries, and understanding about decision processes be used to tailor assessment and decision tools to widely shared needs?
- How are community decision frames, needs and objectives changing in this period of rapid climate, demographic, and economic change, and how can we create resilient/ adaptive decision tools to meet those needs and ensure the relevance of EPA's decision tools for the near and medium term?
- How can ORD leverage digital tools (existing or new) to engage communities in identifying their sustainability challenges and regulatory compliance requirements, eliciting community based suggestions and ideas for solving those challenges, and then infusing the decision making process with those ideas for consideration?

The Key Products for Focus Area #1 include two products related to the state of practice for using decision processes and support tool development. The key products are:

(a) Design innovation guidance for support tools and community relevant decision processes: This product is an on-going assessment mechanism of what in existing tools are useful to communities, combined with a crosswalk of community types, user need/capacities, and relevant group decision strategies, yielding reports that provide information to EPA and external developers regarding best practices for developing tools, including user-interface design, re-use of existing tools and components, and appropriate levels of functionality for different community types and decision contexts. The document will also help highlight gaps in the current tool inventory and provide insight towards interoperability, re-usability of software components, computing platforms, and methods of deployment and development. This product will help EPA and external tool builders, e.g. Ecosystem Based Management Tools Network, design tools and search and delivery platforms with the greatest impact by offering information, and guidance on the needs of different types of communities. Examples of external tool builders that might benefit from this guidance are organizations building scenario planning tools, and organizations such as the Ecosystem Based Management Tools network (EBM Tools). This product will contribute directly to Output 1.61.1, by providing information for software application development for different types and needs of communities, and to Outputs 1.61.3 and 1.61.4, by providing information that can be incorporated into next generation tool design, development, and deployment.

(b) Emerging decision support research and guidance: This product describes emerging decision and computer science methods. Tools will be identified and evaluated for their ability to provide 1) appropriate level of decision-making, and 2) reuse, interoperability, and reduction of redundancies among tools within and external to EPA. A report suggesting how cognitive preferences e.g. bounded rationality, satisficing; and components, e.g. API interfaces and Web relational vocabularies (ontologies), may be integrated into a comprehensive vision of next generation tool development. The guidance will be applied showing discovery and integration of decision methods and components in the development of the demonstration tool (*Tool Category iv*) described below. This product will benefit environmental and sustainability software developers, both internal and external to the Project and Agency. This product will contribute directly to Output 1.61.1, by providing guidance for software application development for different types and needs of communities, Output 1.61.5 in demonstration tool development, and to Output 1.61.4, by highlighting emerging capabilities and features that can be incorporated into next generation tool design and development.

*Focus Area #2: Software Re-Configuration for Community-Based Use* – Devising novel re-combinations of existing software components and interaction platforms serving user needs for data analysis, sustainability assessments, and decision-making. For example, an interoperable component for storm water management using the EPA SWMM model. This component will be

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

Representative questions:

- How can locally-held and owned data be easily incorporated into mapping tools, indicators, and indices, synthesized and made accessible, to enable communities to compare among different areas within the community, allowing insights into where improvements are possible, and informing decisions that promote sustainability and equity?
- What existing SHC tools can be modularized and made interoperable to increase their usefulness and reduce obsolescence?

The Key Products for Focus Area #2 relate to the development of decision tools and include:

(a) Tools for Decisions Affecting Community Sustainability: This product describes software tools, components and documentation that will be developed to support communities in making decisions with more sustainable outcomes. This product is expected to include both the development of new decision support tools, enhancements to existing tools, and methods/components for the delivery of both new and existing tools. Tools selected for development will be those identified as important in the gap analysis, in scope for the EPA mission, and in scope as much as possible to the current EPA skill set. Software tools and components may include:

i. Conventional tools, i.e. desktop applications identified as important in the gap analysis.
ii. Leverage existing components of tools to create software supporting analysis of locally generated data for calculation of indicators that can be used by community specific beneficiaries.
iii. Decision processes and frameworks adaptable to community type, decision method needs, regulatory requirements, and tool functionality. Functionality could include: inter-operable components, cloud-based calculation, risk/uncertainty analysis, systems-level assessment, trade-off analysis, user defined indicators, disparate data and information normalization, optimization components for efficient or combined solutions, visualization capabilities, and audit tools that record decision steps. Open Architecture framework examples (EPA and external) that can integrate tools as plug-in and/or model output include but are not limited to:

a. DASEES is a web-based, open source structured decision making interface supporting problem formulation, scoping, prioritization, and integrated systems level assessment of alternative scenarios.

b. FRAMES is a software-based modeling system (i.e., the infrastructure) within which collections of models and modeling tools (e.g., data retrieval and analysis) are developed and applied to real world problems.

c. **ENVISION** is a GIS-based tool for scenario-based community and regional integrated planning and environmental assessments. It provides a robust platform for integrating a variety of spatially explicit models of landscape change processes and production for conducting alternative futures analyses.

d. Urban Footprint – Urban Footprint is an open source cutting-edge scenario development and modeling tool used to express the varying impacts of development and infrastructure investment choices at a variety of scales.

iv. Tools demonstrating component re-use and interoperability.

v. Inter-operable Cloud-based software components that would allow users to connect and combine tools through the internet.

This product will directly meet Output 1.61.4 by demonstrating the potential of next generation decision support tools. It also will address Output 1.61.2 through targeted re-use of components for specific community and data needs and Output 1.61.5 demonstrating interoperability of existing SHC tools.

*Focus Area #3: Tool Development, Support, and Delivery* – Identifying new areas for tool development, capitalizing on emerging support infrastructure, and providing user-defined search and delivery mechanisms.

Representative questions:

- How can new information technology be harnessed to improve delivery of SHC tools to communities and other users to support application of research results?
- What criteria and standards for future tool development will facilitate collaborative development of decision tools?
- How can SHC target development of new tools or improvement of existing tools (both internal and external) to fill gaps in decision support needed for different types of communities to inform decisions that promote sustainability and well-being?

The Key Products in Focus Area #3 relate to a user needs gap and opportunity analysis and searchable library of available tools and include:

(a) Gap Analysis of Community Tool Needs: This product is based on on-going tool inventory efforts, available models and tools, decision methods, etc. will be categorized according to decision process and community typology to identify coverage and gaps. The gaps identified will point to opportunities to fill high priority community needs. Community typologies are considered an important factor as there are expected to be intersections in expertise, decision needs, shared stressors and high priority concerns. Further, community expertise will be instructive as to the community resources, skills and capacity of potential users. This product will enable SHC to determine the unmet needs for communities, EPA Regions, and program offices. This information will be used

by this and other SHC projects e.g. 4.6 (Systems-based Assessment), to prioritize and guide development of tools. Program offices and regions may find this information useful, both as an opportunity to voice their priorities and possibly to identify opportunities for tool development of their own. This product will contribute directly to Outputs 1.61.3 and 1.61.4, by providing information and priorities on which tools are needed and how they will be used.

(b) An inventory of models, tools, and methods for use by communities: This product will produce a searchable library of models, tools, components and decision methods applicable to supporting decision making; providing information to communities through the Registry of EPA Applications, Models, and Databases (READ) registry. The library user interface will provide sorting/ narrowing capabilities along several possible paths, (decision support taxonomy, structured decision making process, community type, and decision need). Sorting by type would bin tools into, for example, advanced-basic groupings by the level of engagement with sustainability and the capacity of the user. The diagnosis and prescriptive capabilities could be improved by examining user choices (example: WebMD) and learning from this information to support similar users-problem area combinations Interface development will be informed through assessing the field of existing databases and interfaces that have been designed for similar purposes and adopting technology to the extent appropriate and possible, potentially re-using mechanisms developed by non-EPA organizations, where the code is freely available. The data base will be used by EPA regions and community-level decision makers (and available to ORD researchers and Program Office partners) via web-based interfaces. This product will contribute directly to output 1.61.3. It also fulfills in part Outputs 1.61.1 and 1.61.4 by identifying relevant models, tools and methods.

**Nature of the Work**

*Extramural:* Because of the project emphasis on tool development, contract support will most likely be continued with existing tasks to facilitate interoperability/software re-use efforts, in addition to on-going existing tools surveys. There is the potential need for contract support for gap analysis/next generation tools, guidance documents, and searchable database products. Continued typological and new sociological/decision work into user needs/decision process preferences will require contractor support or post doc/SSC support. At a minimum, it is expected that 60% of the work will be completed through extramural vehicles addressing software development, social/decision research, and future tool design and deployment planning.

*In-House:* The most readily available contributions will be the subject specific expertise informing the reuse and interoperability tool development efforts. Co-ordination is required between Project 1.61, OSIM, and OEI to achieve every project output. Continued work with the Registry of EPA Applications, Models, and Databases (READ) Council on Regulatory and Environmental Modeling (CREM), ORD research programs, and external communities of practice are necessary to complete the gap analyses, existing tools surveys, and development of

the searchable database. Social/decision work with communities mediated through Program Offices and Regions will inform the guidance documents, searchable database structure, and next generation tools. Up to 40% in-house contribution to the needed project work is expected to be dedicated to software programming, social and decision context specific expertise, and knowledge and information management specialists.

**Collaboration**

*Internal:*

- Projects 1.62 (EnviroAtlas) and 2.62 (Community Public Health) for software reuse and interoperability efforts
- Projects 2.61 ( Ecosystem Goods & Services) and 2.64 (Indicators and Indices) for tools calculating indicators and indices
- Projects 3.63 (Sustainable Management of Materials) and 4.6 (Systems-based Assessment) for Systems-level assessment and systems framing tools
- Projects 3.61 (Contaminated Sites) and 4.6 (Systems-based Assessment) for application and testing of tools

External:

- OEI and OSIM for life cycle management of existing and next generation tools
- SSWR, CSS, and ACE for searchable database information and next generation tools planning
- Regional community engagement specialists for social/user decision tool use requirements
- Program Offices, Regions, CREM, and OSC for tool gap analyses
- OSWER for assessing remedial alternatives, site re-use and community engagement
- Communities of practice for guidance on existing and new tool development

The scope of this project ventures into areas where EPA has not traditionally invested and reflects the changing perception of how the EPA should meet its mandates. As such, it is *highly desirable* that the skill set shifts over the course of the project towards a greater proportion of FTEs with software design/architecture expertise. Greater in-house ability increases product sustainability and controls extramural costs.

Critical resources

- Web hosting and software development and maintenance support infrastructure e.g. cloud storage/computing.
- Software developers–either in-house (preferred) or via contracting vehicles.

Other Necessary Resources:

- *Subject Specific Expertise*–Input from Theme 4 sector analyses, ORD experts for specific decision contexts, and software communities of practice.
- *Stakeholder Involvement*–Tool requirements from Regions, Program Offices, and communities

- *Project linkages*–Structured communication among SHC projects and other Research Programs facilitating re-use and interoperability

**Assumptions/Constraints**

- Availability of suitable existing components, or tool source code, for demonstration of software interoperability
- Availability of community data and stakeholder co-operation for locally generated sustainability indices
- Co-ordination between ORD and OSIM for the long-term development, support, and maintenance of tools
- Access to existing tools and cooperation from experts to complete a sufficient tool review and gap analysis to identify and prioritize needed tools and functions
- Increased in-house capability for software development

**Project Charter Team Members**

Pat Bradley, NHEERL
Marilyn TenBrink, NHEERL
Susan Yee, NHEERL
Kurt Wolf, NERL
Tim Barzyk, NERL
Gerry Laniak. NERL
Michael Nye, NERL
Rick Ziegler, NCEA
Heriberto Cabezas. NRMRL
Tim Canfield, NRMRL
Scott Jacobs, NRMRL
Dan Loughlin, NRMRL
Wes Ingwersen, NRMRL
Ray Smith, NRMRL
Brenda Groskinsky, Region 7
Betsy Smith, NPD Charter Representative
Abdel Kadry, MI Charter Representative

## 1.62 EnviroAtlas

**Project Number & Title**
1.62 - EnviroAtlas

**Project Lead and Deputy**
Project Lead: Anne Neale – ORD, NERL, ESD
Deputy Project Lead: Laura Jackson – ORD, NHEERL, EPHD
Deputy Project Lead: Megan Mehaffey – ORD, NERL, ESD

**Project Period**
FY16 – FY19

**Project Summary**

Project 1.62, EnviroAtlas, is being developed as a web-based collection of tools and resources that allows users to explore the many benefits people receive from nature, often referred to as ecosystem goods and services. EnviroAtlas allows users to interact with geospatial data at multiple scales, thus providing information that can be used to inform decisions at multiple levels of governance. Until very recently, the types of data that are available in the Atlas were only available to expert users with Geographical Information Systems (GIS) skills and access to powerful computing resources. EnviroAtlas, through research and incorporation of the latest geospatial technology and analyses, allows users with no more than an internet browser to access a wealth of spatially explicit data and analysis tools. Taken in isolation, each piece of information developed by EnviroAtlas can help answer important questions related to the use of resources in a decision-making, policy, and regulatory context. Linked together in an easy-to-use tool, EnviroAtlas creates a powerful means to enable more of a systems approach to inform decision making.

The first release of EnviroAtlas successfully took place in May 2014, but there are still additional data to develop and functionality to add for future releases. Enhancements to EnviroAtlas through research in project 1.62 include: 1) addition of use case studies that will guide the user through real-world decision-making efforts to showcase applicability of EnviroAtlas data and tools to on-the-ground decisions by practitioners; 2) a crosswalk with the Final Ecosystem Goods and Services Classification System (FEGS-CS) that will facilitate linking ecosystem services and associated benefits directly to beneficiaries and improve our ability to account for the value of these services under decision alternatives; 3) new national and community-scale metrics that will allow local- to national-scale comparative analyses to inform decision making; 4) a new analysis tool that will allow insights into the implications of climate change for individual communities; and, 5) new spatial data layers that represent ecosystem service demand, which is crucial to assigning value and evaluating future vulnerabilities.

EnviroAtlas is making data available to users through multiple avenues, maximizing interoperability and data usefulness to a wide group of users. The data are available to

EnviroAtlas users via the following: 1) within the EnviroAtlas Interactive Map tool, 2) through the EPA GeoPlatform where they can be streamed interoperably through a published web service (i.e., user has only to type in the web address of the map and will be able to use the map in their own desktop or online application) and 3) via direct download for desktop access. Having the ability to use the data as a web service through the GeoPlatform is rather unprecedented and takes advantage of advanced technology. Through this technology, data are also available through data.gov whereby reaching an even wider range of users.

**Project Description**

Problem and Decision Context

Communities are under pressure from issues relating to population growth and decline, economic challenges, public health, environmental justice, climate change, disasters, environmental regulations, and others. Communities are impacted by decisions made within their boundaries as well as by policy and decisions made at every level of governance. With a growing urgency to help communities, decision-makers at every level of governance need access to better data and tools in an easily consumable format with relatively low cost to the users.

The use of advanced information technology, web development, GIS, remotely sensed data, landscape ecology science, eco-health science, and geospatial analyses, have enabled the potential for incorporating quantitative and qualitative spatial information into every day decision-making. Simultaneously, ecosystem services as a framework for decision making and as an approach for incorporating economic valuation into environmental decision-making has emerged.

The EnviroAtlas project capitalizes on the above needs and emerging science and technology to provide a publicly accessible web-based tool which allows users to access, view, and analyze diverse information focusing on the benefits that humans receive from their environment and how these benefits affect human health and well-being.

Outputs

- 2016 - Applications of EnviroAtlas to Community Based Decisions (1.62.1)
- 2016 - Crosswalk between Ecosystem Services mapped in EnviroAtlas with those in the FEGS-CS (1.62.2)
- 2017 - Community Metrics for EnviroAtlas (1.62.3)
- 2017 - Climate Change Implication Tools and Data Layers for EnviroAtlas (1.62.4)
- 2018 - Demand for Ecosystem Services Data Layers for EnviroAtlas (1.62.5)

Focus Areas

*Focus Area #1: Improved Functionality and Case Studies* - One aspect of this research will be to develop a crosswalk to allow users to see how mapped ecosystem service indicators and indices from EnviroAtlas crosswalk to the EPA FEGS-CS and the National Ecosystem Services Classification System (NESCS). The use of an ecosystem services classification system is a valuable step in systematically identifying the supply of ecosystem services available in a location over time.

Research in this focus area will lead to a well-developed section in EnviroAtlas showing real-world applications that demonstrate how EnviroAtlas data and tools can be applied to a common high priority decision affecting community well-being with respect to maintaining or promoting good environmental quality, environmental public health and well-being, and community-level preparation for adaptation to climate change.

Case studies or real world applications of EnviroAtlas will be fully developed into guided analyses that allow users to understand what metrics and analytics can be used to support a decision and guides them through the steps needed to complete the analysis. The incorporation of "use cases" or "case studies" will help inform potential users how the data and tools can be used in a real world example. EnviroAtlas users will help develop these use cases, thus allowing applications to be shared amongst communities. Types of decisions that EnviroAtlas data and tools can help inform include identifying priority areas for protection; addressing an impairment; locating infrastructure, restoration, or resource use; identifying sources of impairments; identifying areas for tree planting to maximize benefits, identifying the coarse pathway of a spill, identifying regional patterns, etc.
This focus area will also include improving overall functionality of EnviroAtlas, including recoding from a Flex to a JavaScript front end, which will keep EnviroAtlas at the forefront of online geospatial functionality, allow for more interoperability, and optimize EnviroAtlas for use on mobile devices.

*Focus Area #2: New Tools and Data Layers* - New data layers for the national and the community scale metrics included in EnviroAtlas are derived as the results of research projects. Methods developed will be published as such. This focus area will include the development of nationally-consistent data layers that allow for tracking of local to national conditions and will provide information to inform decision making at local, state, regional, and national scales. This focus area includes the development of data for the community scale metrics contained within EnviroAtlas as well as the national scale metrics. It will include developing metrics based on research investigating the relationships between ecosystem health and human health. Research will be conducted to develop data representing demand for ecosystem services (including ecosystem service-related employment/revenues and recreation demand), and additional indicators of ecosystem production, drivers of change, and beneficiaries. Data layers that have already been developed for EnviroAtlas can be reviewed on the EnviroAtlas web site (http://enviroatlas.epa.gov/enviroatlas/Data/currentdata.pdf). Data yet to be developed have been included as an appendix to this document.

In addition to current condition data, EnviroAtlas will incorporate tools and data layers that will allow users to visualize the implications of climate change on community sustainability. By doing this, EnviroAtlas will move in the direction of incorporating Intergovernmental Panel on Climate Change (IPCC) scenarios of changes in land use, temperature and precipitation and toward creating a tool to allow users to view the implications of these alternative scenarios on various ecosystems services, such as changes in water supply, and mitigation of heat-related health impacts and sea-level rise.

New data and tools for EnviroAtlas will be developed from within the EnviroAtlas team as well as by other projects within ORD that will be contributing to EnviroAtlas. All data and tools to be published within EnviroAtlas will be developed according to a set of criteria. These draft criteria will be finalized in early 2015, and include the following general criteria. In general, all data to be included in EnviroAtlas will be required to meet the following criteria:

- Include all required documentation and adhere to data submission guidelines
- Demonstrate enough of a gradient to be useful and meaningful
- Relate to at least one of the ecosystem services benefit categories
- Interpretable to a general audience once explained
- Data to be included in the "ecosystem services and biodiversity" section must be aggregated to one of the EnviroAtlas spatial units of choice (currently 12 digit HUCs for national and census block groups for community)
- Data to be included in the National "ecosystem services and biodiversity" section must be available for the entire nation (or relevant parts of the nation) and for the appropriate reporting unit.
- Data to be included in the "Supplemental Data" section do not need to be aggregated to a specific spatial unit but will not be available for use in forthcoming analytical tools.

All outputs listed in the previous section along with the improvements to the tool discussed in section c.1 and c.2 will be incorporated into releases of EnviroAtlas. The major peer-reviewed releases of EnviroAtlas will occur in 2016, 2018, and 2020, with annual content updates in 2015, 2017, and 2019. Each release will contain improvements over the previous release, including the following: improved functionality, new tools, updates to current tools, including an updated Eco-Health Relationship Browser tool (http://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/introduction.html), data, use cases, supportive publications in the peer-reviewed literature, and overall improvement of the user experience

*Focus Area #3: Outreach and Communication* - As the target audience for EnviroAtlas is extremely broad, with a goal of providing information for a large number of decision-makers, educators, and researchers, outreach and communication efforts are imperative to the success of EnviroAtlas. This focus area includes developing web materials that will appeal to a wide group of users, including both technical and non-technical audiences. It also includes

developing outreach materials for conferences and stakeholder groups, and conducting stakeholder outreach. It includes soliciting feedback, developing training materials, developing explanatory fact sheets, and conducting demonstrations.

EnviroAtlas will strive to incorporate elements of social networking and citizen science into EnviroAtlas by the 2019 release. New functionality and data will be driven by EPA Program Office (PO) and Regional needs as well as by user community feedback.

**Nature of the Work**

Approximately thirty percent of the work will be done with in-house resources to conduct program management, metric development research, ecosystem and sustainability research, publications, contracts and interagency agreement management, tools and widget development, land cover classification, quality assurance, and communications and outreach. Seventy percent of the work will be done through extramural support. Extramural resources support interagency agreements, software development, student services contracts and fellows, communication and outreach, and "turning the crank" contracts for metric calculation and landcover classification. Typically, EnviroAtlas data and tools are conceived by EPA staff and research fellows, the methods are then developed through research, and metrics are churned out through contract support. Approximately 15% of the EnviroAtlas budget directly supports the development of the National Land Cover Data (NLCD) used widely throughout EPA and other agencies. Approximately 20% of the EnviroAtlas budget supports software development and data management for EnviroAtlas.

**Collaboration**

The EnviroAtlas team will continue to work closely with projects across SHC and other ORD Programs. The research described in this EnviroAtlas Charter could potentially contribute to multiple Projects across SHC and ORD. Likewise, multiple projects across ORD could offer significant contributions to EnviroAtlas. One of the first steps that will be taken to encourage collaboration is to finalize a set of criteria and define a process for data and tool inclusion in EnviroAtlas. EnviroAtlas already successfully includes data that have been provided by collaborative efforts across ORD, but we would like to encourage additional participation. Listing the entirety of all of the potential collaborations and linkages is beyond the scope of this Project Charter, but some of the critical linkages are discussed below.

<u>Project 1.61: Decision Science and Support Tools -</u> EnviroAtlas is a decision tool and it is obviously important that it is developed in collaboration with Project 1.61. Guidance developed in Project 1.61 will be helpful for EnviroAtlas. EnviroAtlas can benefit from IT innovation in the project, especially related to inclusion of citizen science and social networking. EnviroAtlas may contribute to Project 1.61 by providing a platform to display results of citizen science.

Project 2.61: Ecosystem Goods and Services - A key near-term output requires close collaboration with Project 2.61, the crosswalk of FEGS-CS with EnviroAtlas metrics. Data layers contained within EnviroAtlas can be used in Project 2.61 research efforts. Data layers and tools for EnviroAtlas could and should be developed collaboratively between these two Projects. An important goal of 2.61 is the application of FEGS-CS, production functions, and models for spatial display in EnviroAtlas (1.62); thus collaboration between these projects is essential. FEGS-CS should be mutually beneficial, representing high priority research in 2.61 and filling important gaps for achieving EnviroAtlas goals. There is potential benefit for 2.61 Outputs through co-development of metrics, models and tools that identify and map demands (beneficiaries) for FEGS-CS.

Project 2.62: Community Public Health and Well-Being - Research on the role of community "green infrastructure" in specific public health issues will be coordinated and exchanged between EnviroAtlas and Project 2.62. There is a high potential for complementary research and visibility in the SHC Program. Ongoing collaboration with the Community- Focused Exposure Risk Screening Tool (C-FERST) and the Tribal-Focused Environmental Risk and Sustainability Tool (T-FERST) will continue.

Project 2.63: Assessing Environmental Health Disparities and Vulnerable Populations - Research on the role of community "green infrastructure" in specific public health issues in regards to health disparities and vulnerable populations will be coordinated and exchanged between EnviroAtlas and Project 2.63. There is a high potential for complementary research and visibility in the SHC Program. Areas of collaboration could include greenspace, access to recreation, children's health issues, and reduction of roadway pollution.

Project 2.64: Indicators, Indices, and Report on the Environment - Interaction is needed between EnviroAtlas, Project 2.61 and Project 2.64 to maximize the type and quality of indicators and indices relevant to all Projects. Coordination is necessary to reduce the possibilities of duplication of efforts and to ensue appropriate scale is employed. Report on the Environment (ROE) and EnviroAtlas should explore the possibility of using EnviroAtlas as the mapping display driver for ROE.

Projects 3.61, 3.62 and 3.63: TBD

Projects 4.61: Systems-Based Assessments and Application of Systems-Based Assessments for Achieving Sustainability - EnviroAtlas maps and data are expected to contribute significantly to Projects 4.61, involving system-level accounting methods; these will be useful to evaluate ecosystem services supply and threats under alternative community decisions. Project 4.61 is essentially a stakeholder of EnviroAtlas and can provide feedback on how EnviroAtlas data are being used. The feedback can be used by the EnviroAtlas team to develop "use cases" so that examples of how to use EnviroAtlas data can be shared with the user community.

The EnviroAtlas team will continue to collaborate with researchers in the Safe and Sustainable Waters Research Program (SSW) and the Air, Climate, and Energy Research Program (ACE),

both to support SSW and ACE research and to incorporate the results into EnviroAtlas. ACE researchers modeling reductions in near-road pollution due to roadside vegetation are exploring the high-resolution landcover available in EnviroAtlas for local site selection and model validation. Plans include hosting the near-road vegetation model on the EnviroAtlas platform for community use. EnviroAtlas researchers are working with ACE researchers to develop climate scenario information. SSW Project 1.1 is using EnviroAtlas watershed data to model the performance of green infrastructure and to downscale regional and state aquatic resource condition estimates, from EPA's National Aquatic Resources Survey, to 12-digit hydrologic unit codes (HUCs). As the aquatic condition estimates inform ecosystem goods and services production and will align with EnviroAtlas mapping units, they represent important future additions to EnviroAtlas. Additional SSW research slated for collaboration include modeling river floodplains, creating a stream flashiness index, modeling invasive species, and investigating the benefits to water quality and quantity of green infrastructure. SSW researchers are also developing Estuary Mapper, which will contribute to the EnviroAtlas toolboxes its public platform and contribute to the EnviroAtlas toolbox.

A new partnership with the Homeland Security Research Program is evolving. The EnviroAtlas team also collaborates with EPA Office of Water (OW) and Office of Air and Radiation (OAR), U.S. Geological Survey (USGS), U.S. Forest Service (USFS), Landscope America, Natural Resources Conservation Service (NRCS), Duke University, New Mexico State University, Department of Transportation (DOT) and others EnviroAtlas has multiple collaborators outside of Agency, and continues to develop new collaborative working partnerships.

Significant collaborators for the community component include the following:

- USDA Forest Service, with Davey Tree Expert Company
  Description: Run *i-Tree* and BenMAP models using EnviroAtlas community landcover data to create block-group level metrics of hazard buffering by tree cover, with selected health benefits and dollar values. *Interagency Agreement*
- USDA Forest Service, with University of Vermont
  Description: Collaborate on high-resolution landcover classification for large urban areas; facilitate stakeholder outreach and cost-sharing. *Interagency Agreement (under development)*
- University of Michigan School of Public Health, with Duke University
  Description: Collaborate on eco-epidemiology research: urban ecosystem services indicators and birth weight in Durham-Chapel Hill, NC. *Official agreement: University of Michigan Institutional Review Board and NCER Human Studies Official approvals for EnviroAtlas ASPPH Fellow to participate in human studies research*
- Harvard Medical School / School of Public Health, with Brigham and Women's Hospital
  Description: Collaborate on eco-epidemiology research: urban ecosystem services indicators and multiple health measures from the Harvard Nurses' Study, across EnviroAtlas communities. *Official agreement: Harvard University Institutional Review Board and NCER Human Studies Official approvals for EnviroAtlas ASPPH Fellows to participate in human studies research (under development)*
- University of Wisconsin, with Medical College of Wisconsin

Description: Collaborate on eco-epidemiology research: urban ecosystem services indicators and multiple health measures from the Survey of the Health of Wisconsin (SHOW), in Milwaukee and Green Bay. *Official agreement: University of Wisconsin Institutional Review Board and NCER Human Studies Official approvals for EnviroAtlas ASPPH Fellows to participate in human studies research (under development)*

- City of Durham, NC
  Description: Collaborate to apply EnviroAtlas data and information to local decisions. *No official agreement*

Significant collaborators for the national component include the following:

- USGS, Earth Resources and Observation Science Center (EROS)
  Description: Creating gridded soils layers from NRCS Soil Survey Geographic Database (SSURGO) data. *Interagency agreement*
- USGS, Gap Analysis Program (GAP)
  Description: Developing biodiversity metrics for a suite of vertebrate species. *Interagency agreement*
- Fish and Wildlife Service (FWS), South Atlantic Land Conservation Cooperative (SALCC)
  Description: SALCC is creating a blueprint for the southeast for adaption to change and are including data from EnviroAtlas in their efforts. Interested in recreational demand modeling and species data created by EnviroAtlas. SALCC is also helping EnviroAtlas on cultural and aesthetic value metrics. *No official agreement*
- National Aeronautics and Space Administration (NASA)
  Description: NASA is working to create potential evapotranspiration (PET) layers from the Coupled Model Intercomparison Project Phase 5 (CMIP5) climate information that will be included in EnviroAtlas and will also be served on the NASA website for others to use. *No official agreement*
- Forest Trends Initiative (FTI)
  Description: FTI is interested in linking web-services from there mapping application with EnviroAtlas. *No official agreement*
- NRCS
  Description: Soils data development from ecosystem services perspective
- USDA, Office of the Chief Economist
  Description: Bringing ecosystem services markets data into EnviroAtlas. Agreement under development
- FWS
  Description: Using EnviroAtlas to inform prioritization for the purchasing of FWS protected lands. Collaboration under development

The EnviroAtlas Team will strive to collaborate with EPA Program Offices including Office of Solid Waste and Emergency Response (OSWER), OAR, OW, and EPA Regions where opportunities exist and to ensure EnviroAtlas will meet PO/Regional needs. Examples of ongoing collaborative efforts include the Smart Location Data (SLD) with Office of Sustainable Communities (OSC), Recovery Potential work and NHDPlus attributes with OW, and

incorporating data from the National Health Index (from the National Minority Quality Forum) in conjunction with Office of Air Quality Planning and Standards (OAQPS), and partnering with OAQPS to link the Environmental Benefits Mapping and Analysis Program (BenMAP) and EnviroAtlas. Numerous additional collaborative efforts with Regions and Program Offices are ongoing and are too numerous to list.

**Assumptions/Constraints**

- Staff with advanced geospatial analysis skills
- An unencumbered IT infrastructure that allows the incorporation of "big data"
- Transdisciplinary strengths spanning sustainability, and the linkages between ecosystem health and human health
- High-powered computing resources and access to software
- Continued ability to procure student services contractors and research fellows – these individuals perform tasks that are key to EnviroAtlas success
- Continued participation of SHC staff members to conduct remote sensing, metric development, outreach and communication, contract management, etc. Continued leveraging of complementary efforts through interagency agreements with the USDA Forest Service and other agencies engaged in related research activities
- Continued ability to procure IT support. As we have no software engineers on staff, IT contract support is key to success
- Communications and outreach support
- Increased access to sub-county public health data in order to perform eco-epidemiology research; potential sources include CDC's National Environmental Public Health Tracking System and the HHS National Minority Health Data Project.

**Project Charter Team Members**

ORD/NERL/ESD - Neale, Anne; Moore, Rose-Marie; Yuan, Yongping; Conlon, Michele; Christensen, Jay; Wickham, James; Pilant, Drew; Kilaru, Vasu; Mehaffey, Megan
ORD/NERL/AMAD - Schwede, Donna;
ORD/NERL/GED-Russell, Marc; Smith, LisaM; Harwell, Matthew; Summers, Kevin;
ORD/NERL/ERD - Mike Galvin; Parmar, Rajbir;
ORD/NERL/EERD - Darling, John; Bruins, Randall;
ORD/NERL/HEASD - Mintz, Bruce; Quackenboss, James; Tulve, Nicolle;
ORD/NERL/IO - Zartarian, Valerie; Kryak, DavidD; Gillespie, Andrew
ORD/NHEERL/AED - TenBrink, Marilyn; Detenbeck, Naomi;
ORD/NHEERL/WED - Landers, Dixon; Compton, Jana; Brookes, Allen;
ORD/NHEERL/EPHD - Wade, Tim; Jackson, Laura;
ORD/NHEERL/IO- Saterson, Kathryn;
ORD/NCEA/IO - Jarabek, Annie; Kadry,Abdel-Razak; Gwinn, Maureen;
ORD/NCER/HRFD - Payne-Sturges,Devon;
ORD/NRMRL/APPCD - Dodder, Rebecca; Thompson, Bob

ORD/NRMRL/LRPCD - Dyson, Brian; Parker, Randy; Tolaymat, Thabet; Conmy, Robyn; Kremer, Fran;
ORD/NRMRL/GWERD - Weaver, Jim; Tim Canfield
ORD/OAR/OSIM – Bhagya Subramanian, Ann Vega
OAR/OAQPS/HIED – Hubbell, Bryan; Davis, Christine;
ORD/NPD/SHC -Smith, Betsy; McCullough, Melissa;
ORD/NPD/SSWR - McDonald, Michael E.;
OEI/ OTOP- Richards, Tim.

## *Appendix*

This appendix lists data layers anticipated to be including in EnviroAtlas in subsequent releases. This list is tentative with other metrics yet to be added.

Upcoming community layers (i.e., selected communities only) – year after data description indicates anticipated year of addition to EnviroAtlas:

- Number of National Historic Places -2014
- Percentage of working age population with paid employment - 2014
- Number of workers with commutes less than 30 minutes- 2014
- Number of workers with commutes between 30 and 90 minutes- 2014
- Number of workers with commutes greater than 90 minutes- 2014
- Number of federal, state, and local recreational lands within a 2-hour drive – 2015
- Area of federal, state, and local recreational lands within a 2-hour drive- 2015

Upcoming national layers– year after data description indicates anticipated year of addition to EnviroAtlas:

- Future land use scenarios - 2015
- Future population scenarios- 2015
- Future climate scenarios- 2015
- Future water use- 2015
- Fishing, hunting, and wildlife-watching recreation demand- 2015
- Summarized point discharges, nutrients, sediment, and toxics- 2015
- Blue carbon storage- 2016
- Soil organic carbon storage- 2015
- Percent headwater area- 2016
- Amount of agriculture not draining through natural buffer- 2015
- Nitrogen removal metrics - 2016
- Runoff indicators- 2015
- Number of National Historic Places- 2015
- Roads crossing streams- 2015
- Roads near streams- 2015

- Agriculture on steep slopes- 2015
- Superfund sites- 2015
- Wind power potential- 2015
- Biofuels- 2015
- Global Rank Species (G1, G2, G3, and T&E) - 2015
- Conservation GAP Species (Status 1 & 2) - 2016
- Migratory Bird Treaty Act species- 2016
- Grassland Obligate Vertebrate Species- 2016
- Riparian Obligate Vertebrate Species- 2016
- Climate vulnerable bird species- 2015
- Growing Season - average length
- Days over 90 degrees
- Days under 32 degrees
- Date of first & last hard freeze
- Days of sunshine
- Heat index
- Wind chill
- Solar radiation
- Percent calm days
- Atmospheric Particulate Matter (PM2.5) Concentrations
- Atmospheric ozone concentrations
- Cumulative Ozone Exposure for Vegetation
- Days exceeding primary ozone/PM standard
- Mean annual / seasonal visible range
- AQI
- Black carbon
- Base cation deposition
- Mean annual temperature
- Seasonal temperature
- 100-year precipitation return event
- 50-year precipitation return event
- Low flow events
- Ice-free days
- Hurricane tracks/landfall probabilities
- Nitrogen dioxide emissions
- Nitrogen oxide emissions
- Methane emissions
- Carbon dioxide emissions
- Urban area and agriculture in floodplain
- Elevation
- Slope Min/Mean/Max
- Percent steep slopes
- Stream and Lake Buffers >30m for urban lands
- Percent forest core and edge habitat

- Percent of lake and stream buffer that is protected
- Percent of lake and stream buffer that is rare ecosystem
- Erosivity
- Crop Productivity Index (NCCPI)
- Fertilizer application
- Humidity
- Frequency of wind gusts > 60 mph
- Lightning strikes
- Tornado frequency
- Evapotranspiration
- Groundwater recharge
- Number of fish passages and obstructions

Upcoming People and Built Spaces layers (from the Smart Location Database): to be added in 2015

- Population, 2010
- Population density, 2010
- Percent of population that is working aged, 2010
- Number of households that own zero automobiles, 2010
- Percent of zero-car households
- Number of households that own only one automobile, 2010
- Percent of one-car households
- Number of households that own two or more automobiles, 2010
- Percent of households with two or more automobiles, 2010
- Number of workers (home location), 2010
- Number of low wage workers (home location), 2010
- Number of middle-wage workers (home location), 2010
- Number of high-wage workers (home location), 2010
- Percent of all workers earning $1250/month or less (home location), 2010
- Total employment, 2010
- Employment density, 2010
- Retail jobs
- Office jobs
- Industrial jobs
- Service jobs
- Entertainment jobs
- Education jobs
- Health care jobs
- Public administration jobs
- Number of low wage workers (work location), 2010
- Number of middle-wage workers (work location), 2010
- Number of high-wage workers (work location), 2010
- Percent of all workers earning $1250/month or less (work location), 2010

- Total housing units, 2010
- Residential density, 2010
- Jobs-housing Balance
- Land use entropy
- High-speed road network density
- Street intersection density
- Multi-modal street network density
- Pedestrian-oriented street network density
- Multi-modal street intersection density
- Pedestrian-oriented street intersection density
- Peak pm transit service
- Transit service density
- Percentage of employment within ¼ mile of rail transit stop
- Percentage of employment within ½ mile of rail transit stop
- Jobs within a 45-minute transit commute, weighted
- Working-age population within a 45-minute transit commute, weighted
- Jobs within a 45 minute drive, weighted
- Working age population within a 45 minute drive, weighted
- Jobs within a 45-minute transit commute, weighted
- Working-age population within a 45-minute transit commute, weighted
- Regional centrality index – Automobile accessibility
- Regional centrality index – Transit accessibility

---

## 1.63 Environmental Workforce and Innovation

**Project Number & Title**
1.63 - Environmental Workforce and Innovation

**Project Lead and Deputy**
Brandon Jones - NCER

**Project Period**
FY16 – FY 19

**Project Summary**
The innovation and technology explosion over the last century has led to vast human benefits in terms of standard of living, health care, education, communication, mobility, and many other measures. Because most innovations and new technologies were designed with a specific benefit in mind, they produced such side effects as resource depletion, ecosystem degradation, hazardous waste, and disproportionate human exposures to toxics. As part of the Federal effort to incentivize research and innovation, activities in this project are focused on connecting to the academic and private sectors for workforce development, innovative research and sustainable technologies. Project activities are part of an overall effort to address existing environmental problems and, more importantly, to empower communities to apply more sustainable ideas, designs and ways of living.

**Project Description**

Problem and Decision Context

*Fellowships:* EPA recognizes that scientific, technical, engineering and mathematical (STEM) competence is essential to the Nation's future wellbeing in terms of national security and competitive economic advantage. Community health and vitality is predicated, in part, on 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 environmental issues that are pressing to society. The Fellowships help defray costs associated with advanced, environmentally-oriented study, leading to a bachelor's, master's or doctoral degree. Fellowships are rewarded, in part, based on the stated goals of applicants with respect to further engagement in environmental research, adherence to EPA statutes and policies while conducting research, and aligning of stated research goals with assessment criteria, including how research goals will promote sustainability principles.

*People, Prosperity and the Planet (P3):* Providing opportunities for upcoming generations to understand the concept and importance of sustainability are critical as communities move forward to a more balanced approach regarding how humans interact with the environment

and its associated services. EPA's People, Prosperity & the Planet Program (P3) is an innovative student design competition for sustainability. Student teams are involved in projects that provide benefit to people, promote prosperity and protect the planet by designing tangible, cutting-edge solutions for communities to use to address environmental challenges. EPA's P3 offers students and faculty the opportunity to work in multidisciplinary teams to address challenges to sustainability and to move ideas toward demonstration or the marketplace. P3 proposals are evaluated and awarded for their potential to produce sustainable solutions while providing students and faculty with applied experiences in promoting the environmental sciences and sustainable solutions.

*Small Business Innovation Research (SBIR):* SBIR is intended to support the development of technologies that will ultimately be commercialized and improve our environment and quality of life, create jobs, increase productivity and economic growth, and improve the international competitiveness of the U.S. technology industry. SHC manages EPA's SBIR Program where awards are made to small, high-tech companies to help develop and commercialize cutting-edge environmental technologies. Awards are in two phases, first, to prove the scientific merit and technical feasibility of the proposed concept and, if successful, to next develop and commercialize the technology. Annual contracts to small businesses are awarded to move ideas toward the marketplace.

Outputs

FY 16 - A Synthesis of Innovative ideas from the SBIR and P3 Programs

Focus Areas

*Focus Area #1: Fellowships* - The GRO Undergraduate and STAR Graduate Fellowship programs were initiated in 1982 and 1995 respectively. Both 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 goal of the programs are to encourage promising students to obtain advanced degrees and pursue careers in an environmental field. This goal is consistent with the mission of EPA, which is to provide leadership in the nation's environmental science, research, education, assessment, restoration, preservation, pollution prevention and sustainability efforts. 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. They have also provided new environmental research in engineering and in the physical, biological, health, and social sciences.

Some key products and aspects of the Fellowship programs include:

- Programmatic metrics
- Publications
- Presentations
- Simulation Models

- Solicitations
- Awards

- Peer Review
- Programmatic Review
- Decision Meeting
- Program Funding
- Program Management
- Contract Management
- Social Networking
- Communication Management
- Conference Planning
- Federal STEM activities and planning
- Outreach and networking

*Focus Area #2: People, Prosperity and the Planet (P3) & Small Business Innovation Research* - Increased awareness and understanding of sustainability are critical components for promoting a systematic shift towards more environmentally benign and sustainable products, processes, and systems. It is essential that all involved in the design, discovery, demonstration, and implementation of sustainable innovations understand the fundamental techniques and principles that underlie sustainability. Innovative research can take the form of wholly new applications or applications that build on existing knowledge and approaches for new uses.

Programs like 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 the primary source of new technologies that can provide improved environmental protection at lower cost with better performance and effectiveness. P3 & SBIR have helped 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.

Some key products and aspects of the P3 & SBIR programs include:

- Programmatic metrics and reports
- Curriculum development
- Patents
- Publications
- Environmental technology market research analysis
- Job formation
- Non-profit formation
- For-profit formation
- Deployed sustainable technologies
- Improved public understanding of sustainability principles and applications

- Program funding
- Phase I & II Grants
- EPA P3 Competition at the National Sustainable Design Expo (NSDE)
- Contractor support
- Program management
- Contract management
- Communication management
- Grants management
- Outreach and networking with audience and partners
    1. Academia
    2. Professional societies
    3. Other federal agencies and departments
    4. Education societies
    5. International Community
    6. Entrepreneurial community
- Solicitations
- Peer Review
- Programmatic Review
- Phase I & II Awards
- Phase I Final Reports

**Nature of the Work**

*Fellowships:* 100% of the fellowship budget goes to review of applications, awards, awards management, and integration of STEM program activities across the Federal enterprise.

*P3 – People, Prosperity and the Planet:* 100% of the budget goes to review of applications, extramural research grants, grants management, synthesis, associated program support, and showcasing annual team projects at the national Expo.

*Small Business Innovation Research:* 100% of the budget goes to review of applications, extramural research contracts (awards), contracts management, synthesis and the associated program support.

**Collaboration**

*Fellowships:*

- ORD Labs and Centers
- EPA Program Offices
- Professors/Advisors
- Undergrad and Graduate Students
- Professional Societies
- Academia

- Federal STEM Enterprise

*People, Prosperity and the Planet (P3):*

- General Public
- ORD Labs and Centers
- EPA Program Offices
- Professional Societies
- International development community
- Venture and Angel Investor Community
- Entrepreneurial and Small business community
- Business and entrepreneurial academic education

*Small Business Innovation Research (SBIR):*

- General Public
- ORD Labs and Centers
- Federal SBIR Enterprise
- International development community
- Venture and Angel Investor Community
- Entrepreneurial and Small business community

**Assumptions/Constraints**

*Fellowships:* Assumptions -The annual cycle of the program and its relation to the academic calendar is key to the success of the program. The timing of fellowship awards and reaching the participating students in time for them to pursue their work is critical. Timing of awards is important to conducting a fair and robust competition.

Constraints - Agency policies regarding placement of non EPA personnel in EPA facilities (GRO Internships) are somewhat cumbersome but successful. , The application of grant and contract policies, as well as RFA clearance and award procedures often create hurdles as Fellowship awards supports individuals when most Agency policies concerning assistance agreements are focused on institutional awards.

*People, Prosperity and the Planet (P3):* Assumptions – Decisions and administrative support are responsive to the annual cycle of the program and its relation to the academic calendar. The success of the program is contingent upon timing of grant awards and reaching the participating schools in time for them to pursue their work. Timing of awards is critical to conducting fair and robust competition.

Constraints – EPA's P3 Program is unique in the federal challenge and innovation contest arenas for participants because EPA offers a broad range of topics and the competition is open to any U.S. college or university. This broad scope attracts highly qualified investigators and creative

students. However, the bureaucratic process associated with each of the above milestones makes applying to P3 less attractive. P3 stakeholders "live" in the annual cycle of the academic calendar. The current bureaucratic processes threaten the program's viability by seriously constraining EPA's ability to award grants in sync with academic calendars and stay relevant with research and innovation trends. Streamlining the bureaucratic processes will improve the program by ensuring EPA sparks and propels the cutting edge in the sustainable technology research arena.

*Small Business Innovation Research (SBIR):* Assumptions – As an Agency Program that is administered through ORD, SBIR is mandated by law and an annual solicitation is required. SBIR budget is a specific set-aside of the EPA extramural R&D budget. The small business administration administers the government wide SBIR program.

Constraints – Personnel and length of time to make awards.

**Project Charter Team Members**

April Richards – NCER/SBIR
Cynthia Nolt-Helms – NCER/P3
Greg Lank – NCER/SBIR/P3
Mary Wigginton – NCER/P3

## 2.61 Final Community-Based Ecosystem Goods and Services

**Project Number & Title**
2.61 - Final Community-Based Ecosystem Goods and Services

**Project Lead and Deputy**
Matt Harwell (NHEERL) and Ted DeWitt (NHEERL)

**Project Period**
FY16 – FY 19

**Project Summary**

An important goal of SHC is to allow community stakeholders and national decision-makers to be better able to assess and predict the interactions between human communities and the natural environment. Project 2.61 will use scientific knowledge of ecosystem services and human health to promote community well-being and maintain or restore high environmental quality. In broadest terms, research in this project will focus on: 1) the specification, classification, measurement, and modeling of final ecosystem goods and services (FEGS; those ecosystem goods and services that people directly use, enjoy, or otherwise benefit from)); 2) linkages of delivery of FEGS to beneficiaries within communities (including to members of vulnerable populations); 3) measurement of the benefits of FEGS with particular attention to human health and human well-being endpoints; 4) examination of the effects of climate change and other co-occurring stressors to the production and delivery of FEGS; and 5) linkages of this research to the EnviroAtlas and other decision support tools. Project 2.61 will involve the development and integration of these research elements, in part, through the utilization of coordinated case studies for conducting research to help inform communities about making decisions with sustainable outcomes, and assess the transferability of FEGS-based decision support tools to other locations. The Products and Outputs from this Project are intended to directly contribute to the sustainability approaches developed in the Integrated Solutions for Sustainable Communities Project (SHC 4.61) and to inform decision-making about sustainability at national, regional, and community scales by EPA Program Offices and the Regions. This project will have specific activities that focus on synthesis including integration and analysis of tool transferability.

**Project Description**

Problem and Decision Context

Community stakeholders and national decision-makers need to be better able to assess and predict the interactions between human communities and the natural environment. Project 2.61 will use scientific knowledge of ecosystem services and human health to promote community well-being and maintain or restore high environmental quality to address the following science questions:

- *How do social, economic and environmental drivers (particularly climate change and co-occurring stressors) impact the production, supply, delivery and benefits of final ecosystem goods and services related to community sustainability?*
- *How do changes in the production, supply, delivery and benefits of final ecosystem goods and services affect how a community approaches decisions (including decision-making processes) about sustainability?*
- *How can case studies demonstrate applicability and transferability of models that estimate the production and delivery of final ecosystem goods and services production, and the attendant benefits to a populace to inform decisions affecting community sustainability?*

Project 2.61 will contribute to sustainability approaches developed elsewhere within SHC, and inform decision-making about sustainability at national, regional, and community scales by EPA

Program Offices (such as OW, OAR, OSWER, and OSC), EPA Regions (all), and decision makers in local communities. Project 2.61 will inform specific partner needs, including the need to:

- Have a process by which the demands for FEGS by communities, regions or nation-wide can be identified;
- Have a process by which communities can use research-identified metrics of relevant FEGS, and methods to use (measure, map, model, interpret and report) those metrics, with which communities can better manage the sustained delivery of those FEGS and their attendant benefits;
- Identify and/or target ecological models of ecological production of relevant FEGS (e.g., FEGS production functions), assess whether and how ecological production models can be transferred among communities of interest, understand the data requirements to use those models, and understand the uncertainties associated with applying those models to new contexts;
- Determine demands for, uses of, delivery of, and access (or exposure) to FEGS by a populace (e.g., of a community, region or the nation), especially for focal FEGS;
- Determine how sectors of a community use and benefit from FEGS, particularly for the economic and public health of the population, and identify methods by which communities may quantify some of these benefits;
- Understand how climate change and other major drivers and stressors (including incremental changes of stressors) affect the production, delivery of, and benefits of FEGS, including effects on the intermediate ecosystem services upon which FEGS depend;
- Use conceptual frameworks and decision support tools to characterize relationships among stressors, FEGS production, and the well-being of a populace; and,
- Use these tools to identify potential trade-offs so that decision makers can identify and consider management actions that will affect the sustainable delivery of relevant FEGS. For example, these tools could be used to inform decision-making relevant to community-level adaptations to climate change.

<u>Outputs</u>

2.61.1 Ecosystem Goods and Services Production and Benefit Functions Case Studies Report. (FY16)

2.61.2 Incremental report on the impacts of human actions and environmental forces (particularly climate change), on the production and supply of final ecosystem goods and services (FEGS) and the effects on human health and wellbeing. (FY17)

2.61.3 Provide information about the impacts of 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. (FY18)

2.61.4 Incremental report on the impacts of human actions and environmental forces (particularly climate change), on the production and supply of final ecosystem goods and services (FEGS) and the effects on human health and wellbeing. (FY20)

Focus Areas

Research in Project 2.61 will be conducted at both a thematic scale (i.e., generalized research on each focus area, below) and at community-level scale within a small set of coordinated case studies. The purpose of case studies is to evaluate and improve those generalized methods and tools at multiple locations around the U.S. using a common conceptual framework, and thus assess which of those may be most readily transferred among other communities. The research in Project 2.61 has five focus areas that will leverage relevant emerging science and represent an innovative way to advance ORD's research in ecosystem service science:

*Focus Area #1: Final Ecosystem Goods and Services (FEGS) Classification, Metrics and Production* – The scope of this focus area includes quantifying the linkages between the production of ecosystem goods and services to changes in human health (including intermediate and incremental changes and indirect human health endpoints) and other measures of human well-being. Future development of production functions for FEGS will be supported within this Project with targeted linkages to coordinates case studies, EnviroAtlas and other programmatic decision support needs. While the major focus is on FEGS, development of information on intermediate ecosystem services is also important in order to model, manage and assess FEGS. Future FEGS activities will include developing a process to identify and develop metrics and indices to measure FEGS, and to apply that process to develop metrics and indices for specific FEGS needed elsewhere in this Project and SHC. Early efforts in the Project will focus on leveraging the work done to date, including past efforts to identify and quantify metrics and indicators of FEGS, on linking the FEGS-Classification System (FEGS-CS) to the National Ecosystems Services Classification System (NESCS). Research will also identify or generate models to connect those metrics to the ecological processes that underlie the production of the entities that those metrics represent. Two key tools developed under this focus area will be the FEGS-CS website (e.g., describing ecosystem-specific FEGS and their metrics) and the EcoService Models Library (ESML) website (e.g., a tool to help people find ecological models that are useful for estimating production of ecosystem goods and services).

Key products associated with this focus area include:

- Report on integration of FEGS-CS into the NESCS (collaboration with the Benefits of FEGS focus area and EPA Office of Water)
- FEGS-CS Website version 2
- EcoServices Model Library (ESML) version 2 - with increased content and improved functionality for users to find and evaluate ecological models (FEGS)
- A methodology to assess the transferability of ecosystem service production functions and estimates
- Transfer of the FEGS-CS and ESML websites to non-ORD owners

*Focus Area #2: Benefits of FEGS* – The scope of this focus area includes identifying how the supply and benefits of FEGS are delivered to different populations, including specific population groups within a community (including vulnerable populations). Quantifying the benefits of FEGS will focus on targeted efforts to establish associative linkages between FEGS (or intermediate ecosystem services, as appropriate) and endpoints or indicators of benefits – specifically to human health endpoints (including intermediate and incremental changes and indirect human health endpoints), and the equitable delivery of FEGS to communities and vulnerable populations (i.e., environmental justice). Most of the benefits research will occur within the case study context, but not exclusively. Research will likely focus on the ability to utilize specific benefit understanding or functions across communities. This Project's greatest contribution to valuation of ecosystem services is through the coupling of FEGS to national economic accounting systems through our collaboration with the Office of Water on development of NESCS. Research linking FEGS to human health endpoints will receive particular attention. Criteria for human health endpoints may include: integration with Project Plan development for the Community Public Health and Well-Being and Assessing Environmental Health Disparities and Vulnerable Populations Projects (SHC 2.62 and 2.63, respectively); endpoints of concern for coordinated case study communities, EPA Programs and Regions; endpoints with which FEGS can be expected to interact significantly; and availability of the right expertise/resources within this Project.

Key products associated with this focus area include:

- Report on integration of FEGS-CS into the NESCS (collaboration with the FEGS Classification, Metrics, and Production focus area and EPA Office of Water)
- Report on the quantitative linkages between Final Ecosystem Goods and Services and human health – a potential collaboration with the Community Public Health and Well-Being Project (SHC 2.62)

*Focus Area #3: Climate/Stressors* **–** The scope of this focus area includes quantifying the effects of climate change and co-occurring stressors (defined as specific additional stressors whose impacts may be compounded with the presence of stressors associated with climate change) on the production and benefits of FEGS, with particular attention to human health endpoints. This Project will prioritize and develop scenarios addressing effects of climate change associated stressors on production and delivery of FEGS. Scenarios for climate change will be selected through discussion with research efforts across ORD and likely will reflect a compromise among tasks within the project, in particular the Case Studies, to maximize both the appropriateness of scenarios for each study and comparability across studies. This Project will encourage ORD to establish a core set of climate scenarios, which we will then use. Barring that, the Project likely will use the climate scenarios recently adopted by the Decision Science and Support Tools Project (SHC 1.61). Additionally, this Project will develop a generalized conceptual framework (or approach) that includes evaluating the effects of co-occurring stressors on FEGS (as

prioritized within the coordinated case studies), with the goal that the framework/approach can be transferred to evaluating the effects of other types of stressors on FEGS.

The key products associated with this focus area include:

- Report on approaches to estimate the effects of climate change and other stressors on the production and benefits of FEGS

*Focus Area #4: Coordinated Case Studies* – The scope of this focus area includes advancing the development (including the utility) and application of transferable and scalable conceptual frameworks, mathematical models, assessment methods, metrics and indicators relating to the identification, sustainable production and benefits of a core group of community-relevant FEGS under a case study umbrella. The case studies will include a core of research elements that will be studied in common at each site, including a common set of methods to identify sets of FEGS and associated metrics, stressors, beneficiaries, and decision support tools. These focal core elements will provide the basis for comparing research results across case studies. Other community-specific research elements will be included for each case study to address site-specific issues of interest to that community. New elements will be folded into the future direction of ecosystem services research within this Project, including the further distinction between intermediate and final ecosystem services and will focus on strengthening connections to elements of human health, environmental justice (especially vulnerable populations), and climate change. Near-term work will look at establishing – and building upon existing – conceptual relationships among those elements, with future efforts focused on developing quantitative relationships among major drivers of change (and their associated stressors), production of FEGS to communities, and consequent changes to human well-being (particularly public health). Selection of case study sites will be based on objective criteria including community typology (using typologies being developed within SHC), interest by EPA Offices or Regions, availability of data, collaborators in other SHC Projects (such as EnviroAtlas: A Geospatial Analysis Tool; SHC 1.62, and Integrated Solutions for Sustainable Communities; SHC 4.61), and willing partners in the local community. At this time, coordinated case study research is likely planned in San Juan, Puerto Rico, and AOC (areas of concern) communities in the Great Lakes region. Additional potential candidate sites include Snohomish River basin (Puget Sound, WA), Long Island, NY, and communities in the Gulf of Mexico. Comparisons of results across case study communities will be the basis for assessing transferability of ecosystem service-based methods, metrics, tools and models to other communities.

Key products associated with this focus area include:

- Report on the synthesis of results from previous SHC case studies, and the transferability of the methods, data, tools, and models from those studies to support community-scale, sustainability decision-making
- Report on development of transferable frameworks and tools to inform community level decision making for sustaining the availability of core ecosystem goods and services

- Report on incorporation of methods to estimate the production and benefits of FEGS into decision support tools

*Focus Area #5: Integration, Synthesis and Strategic Communication* – The scope of this focus area includes the coordination and integration of research across the focus areas and among the case study locations, and the communication of our results to our EPA partners, the general public, and the scientific community. The goal of this focus area is to assess the transferability, scalability, applicability, and relevance of ecosystem service-related frameworks, models, methods (including involving community engagement), and tools that link the production of FEGS to human health and well-being. Those assessments then may be used to inform sustainability-related decision-making, as conducted under the auspices of EPA Regions, other SHC Projects (e.g., Integrated Solutions for Sustainable Communities; SHC 4.61), or independently by communities. This Project will have an "integration and synthesis" Task that synthesizes the work done by all Tasks (such as use of decision support tools, generic frameworks, and efforts from community engagement); that tracks the collaborations and information flows among Tasks and between this Project and other SHC Projects; and that manages communication with this Project's Key Clients. This Task will be staffed by research leaders of all other Project 2.61 Tasks to better insure that integration, synthesis, and communication efforts will be a shared responsibility of all Tasks for this Project.

Key products associated with this focus area include:

- A managed vocabulary for natural and social scientists to agree on common and useful ecosystem service vocabulary
- A comparison of approaches that model the production and benefits of Final Ecosystem Goods and Services to inform community level decision-making
- A report on the transferability of methods and tools developed in Project 2.61 to support sustainability-focused decision making at community and national scales.
- Periodic self-assessments on the success of Project 2.61 at achieving the goals outlined in this Charter, the integration of research across Tasks and case studies, and the communication of our results to EPA Offices and Regions, community stakeholders, and the scientific community.

**Nature of the Work**

Project 2.61 research will involve a combination of field, lab- and computer-based work, and community and stakeholder engagement. Project 2.61 will require ecologists, ecological modelers, statisticians, physical scientists, and epidemiologists and other human health disciplines. Social scientist needs for Project 2.61 include expertise in sociology, anthropology, decision sciences, policy analysis, and economics. Informational science needs include GIS specialists, web developers and web services (e.g., GeoPlatform, EnviroAtlas), computer

programming, communication specialists, database programming and management, QA/QC specialists, and Contracting Officer Representatives. No more than 50% of the work in the focus areas will be dependent upon extramural funding for GIS specialists, statistical modeling and analysis, economics and social science, programming, data entry, data purchases, web development, web services, ORISE Post-docs and SSCs. Project 2.61 would benefit from opportunities to participate in the RESES or RARE/RM programs and opportunities for ecological and decision-support modeling work.

**Collaboration**

Project 2.61 will work with colleagues in other SHC Projects to integrate metrics, models, and other tools into decision support tools (i.e., the Decision Science and Support Tools and EnviroAtlas: A Geospatial Analysis Tool Projects [SHC 1.61 and 1.62, respectively]), community public health and well-being (i.e., the Community Public Health and Well-Being and the Assessing Environmental Health Disparities and Vulnerable Populations Projects [SHC 2.62 and 2.63, respectively]), systems-scale integration of environment, economy, and human well-being (i.e., the Integrated Solutions for Sustainable Communities Project [SHC 4.61]), and incorporation of ecosystem services into environmental restoration, remediation, and community revitalization (referred to as R2R2R). Expectations and commitments for achieving Products from collaborations will need to be documented during early Project Plan development. The following SHC Projects elements have been identified as potential project collaborations:

<u>Decision Science and Support Tools Project (SHC 1.61)</u>

1.61.2 Methods to allow communities to calculate indicators and indices of sustainability and well-being using local data (FY17)

1.61.3 Searchable Library of Available Community Decision Support Tools and Modules; Software to Help Users Identify and Use Appropriate Tools for Their Needs (FY18)

1.61.4 Next-generation decision support tools that capitalize on existing re-useable software and advances in information technology to ensure interoperability while filling gaps in tools currently available to inform community decisions that promote sustainability (FY19)

<u>EnviroAtlas: A Geospatial Analysis Tool Project (SHC 1.62)</u>

1.62.2 Crosswalk between ecosystem services mapped in the EnviroAtlas with those in the final ecosystem goods and services classification scheme (FY16)

1.62.3 Community metrics for EnviroAtlas (FY17)

1.62.4 Climate change implication tools and data layers for EnviroAtlas (FY17)

<u>Community Public Health and Well-Being Project (SHC 2.62)</u>

2.62.1 Demonstrations of applying tools, methods, and community engagement to mitigate environmental health impacts in at-risk communities (FY16)

2.62.2 Synthesis of best practices learned from community participatory studies that address environmental health concerns within communities (FY17)

2.62.3 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 (FY16)
2.62.4 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 (FY18)

Assessing Environmental Health Disparities and Vulnerable Populations Project (SHC 2.63)
2.63.1 Development of a systems level approach to understanding children's environmental exposures, health and environmental diseases (FY15)
2.63.2 Translational research to incorporate data and information on children's environmental health (CEH) into tools to inform community actions (FY19)
2.63.3 Research to inform Tribal sustainability (FY19)
2.63.4 Evaluation of tested approaches to resolving health disparities in vulnerable populations and lifestages (FY19)

Indicators, Indices, and Report on the Environment Project (SHC 2.64)
2.64.2 Provide indicator information necessary for the incorporation of environmental indicators into SHC Decision Support Tools (FY17)
2.64.3 Draft Report on the Environment (ROE) – 2017 with interpretation of trends (FY17)
2.64.4 Incremental report on the State of the Practice for Environmental Indicators, including Community Sustainability and Indicators of Well-Being (FY19)

SHC Theme 3: Contaminated Sites; Oils and Fuels; Materials Management) (SHC 3.61, 3.62)
Potential collaboration will provide 2.61 with application and grounding of FEGS production, benefits and response to stressors in real environmental scenarios to link remediation to ecological restoration and community revitalization (R2R2R). Evaluating effects of stressors on FEGS is a strong element of Project 2.61 and thus may be relevant for Theme 3 (most likely the contaminated sites project). The potential exists to transfer FEGS and benefit endpoints into activities related to damage assessments, remediation, and restoration.

SHC Theme 4: Integrated Solutions for Sustainable Communities (SHC 4.61)
Within the scope of this Project, coordination will occur with the Integrated Solutions for Sustainable Communities Project (SHC 4.61). This will be done through an exchange of information on methods and tools to examine community sustainability and lessons learned from previous place-based research on Ecosystem Goods and Services (FY16). Additionally, this Project will also collaborate to identify potential opportunities for ecosystem goods and services work in the SHC 4.61 demonstration projects.

Other Collaborators
Potential collaborations with key stakeholders will need to be initiated and documented during Charter review and early Project Plan development. At the time of drafting, the Project has identified the following Program Offices and Regional POCs:

- EPA Regional partners – Mike Morton (R6); Matt Small (R9)

- National Center for Environmental Economics (NCEE)
- Office of Water (OW) – Joel Corona
    - Healthy Watersheds Program (Laura Gabanski)
    - Recovery Potential Assessments (Doug Norton)
- Office of Sustainable Communities (OSC) Office of International and Tribal Affairs (OITA ) – Bill Sonntag
- Office of Air and Radiation (OAR) – Rick Haeuber (OAR/OAP)
- Office of Air Quality Planning and Standards (OAQPS) – Randy Waite
- Office of Solid Waste and Environmental Remediation (OSWER ) – Kathleen Raffaele
- Stakeholders in communities that were part of recent SHC ecosystem services research, including Tampa Bay (FL), Guánica Bay and San Juan (PR), Pensacola Bay (FL), Sweet Home (OR), and Duluth (MN).
- Stakeholders in future coordinated case study communities
- RARE and RESES are potential additional resources

This Project has identified several potential collaborators outside EPA, including:
NOAA Northwest Fisheries Science Center (Ecosystem Sciences group)
USGS Science and Decision Center
US Forest Service
US Department of Interior
Earth Economics
Natural Capital Project
Marine Ecosystem Services Partnership
Harte Research Institute for Gulf of Mexico Studies
OSTP's Subcommittee on Ecosystem Services (Sarah Gerould; USGS)

**Assumptions/Constraints**

Successful incorporation of new research elements into SHC Project 2.61 will depend on strong cooperation and collaboration with experts from other SHC Projects, ORD national programs, EPA Program Offices and Regions, and outside the Agency. In addition to requiring the suite of expertise resources outlined in the Nature of the Work section, the additional primary assumptions and constraints for each of the different research elements within this Project are:

FEGS: A group of focal FEGS need to be articulated clearly in Project Plan development that will be a common element of research under all of the focus areas. Development of metrics of the focal FEGS must be completed by FY16 so that they may be incorporated into the coordinated case study research. Some of the ecosystem service-based tools and decision-frameworks may be limited to what develops based on these focal FEGS.

Beneficiaries: A typology for linking FEGS to classes of beneficiaries must be developed so that the delivery and use of FEGS within communities can be assessed in a comparable fashion within the coordinated case studies.

Human health and environmental justice benefits: Strong connections are needed between the ecosystem services, human-health, and environmental justice research communities, especially given the limited human-health and social science expertise among federal staff assigned to Project 2.61. Linkages for human health responses to changes in ecosystem service availability cannot be solely descriptive. Nor can the availability of FEGS to vulnerable populations be solely qualitative. Potential linkages between FEGS and human health-endpoints and vulnerable populations need to be defined in FY15 and mechanistic work must start no later than FY16 so that these connections can be included in the coordinated case study research. This could be accomplished by close collaboration with the Community Public Health and Well-Being and Assessing Environmental Health Disparities and Vulnerable Populations Projects (SHC 2.62 and 2.63, respectively).

Economics/Valuation of FEGS: FEGS valuation work will be conducted in support of specific FEGS within case studies. It will not be feasible to comprehensively address valuation of FEGS because of limited staff with required expertise associated with Project 2.61. There are numerous other efforts going on around the country and the world to develop databases and tools for valuation of ecosystem services that this Project can leverage.

Transferability: An approach for objectively assessing the transferability of FEGS-based metrics, data, and decision-support tools needs to be developed to evaluate whether research-results in Project 2.61 can be used in communities other than those studied herein. That transferability approach may be based on the Project 2.61 research to develop methods to assess transferability of estimates and models of ecosystem service production.

Climate change/stressors: The selection of climate change scenarios, leveraging other ORD work for scenarios where available, and other co-occurring stressor elements will be constrained by what is available from existing information or work by others outside the Project. This Project will encourage ORD to establish a core set of climate scenarios. Barring that, the Project likely will use the climate scenarios recently adopted by the Decision Science and Support Tools Project (SHC 1.61).

Collaborations: The EPA and other collaborators list should not be considered all-inclusive, nor should be viewed as the de facto criterion for soliciting or funding external partners.

Strategic Coordination: Comparison of results across focus areas and among case studies, and the assessment of the transferability of methods, data, and tools developed in each Task depends on the willingness of staff within Project 2.61 to coordinate their research and prioritize their efforts on focal FEGS, benefits, metrics, stressor scenarios, and decision-support tools. Task and research leaders must agree to be objective in defining success of the research and transferability of the results to new locations.

**Project Charter Team Members**

Ted Angradi (NHEERL/MED)
Craig Barber (NERL/ERD)
Jake Beaulieu (NRMRL/WSWRD)
Dave Bolgrien (NHEERL/MED)
Randy Bruins (NERL/EERD)
Tim Canfield (NRMRL/GWERD)
Wayne Cascio (NHEERL/EPHD)
Jana Compton (NHEERL/WED)
Ellen Cooter (NERL/AMAD)
James Crooks (NHEERL/EPHD)
Sally Darney (NHEERL/TAD
Ted DeWitt – DPL (NHEERL/WED)

David Diaz-Sanchez (NHEERL/EPHD)
Dave Ferguson (NRMRL/STD)
Bill Fisher (NHEERL/GED)
Richard Fulford (NHEERL/GED)
Jane Gallagher (NHEERL/EPHD)
Ahjond Garmestani (NRMRL/STD)
Matt Harwell – PL (NHEERL/GED)
Betsy Hilborn (NHEERL/EPHD)
Joel Hoffman (NHEERL/MED)
Matt Hopton (NRMRL/STD)
Laura Jackson (NHEERL/EPHD)
Scott Jacobs (NRMRL/LRPCD)
Dixon Landers (NHEERL/WED)
Danelle Lobdell (NHEERL/EPHD)
Marisa Mazzotta (NHEERL/AED)
Bob McKane (NHEERL/WED)
Wayne Munns (NHEERL/AED)
Annie Neale (NERL/ESD)
Mike Papenfus (NHEERL/WED)
Jim Power (NHEERL/WED)
Ana Rappold (NHEERL/EPHD)
Paul Ringold (NHEERL/WED)
Marc Russell (NHEERL/GED)
Joe Schubauer-Berrigan (NRMRL/LRPCD)
Mike Sierszen (NHEERL/MED)
Anett Trebitz (NHEERL/MED)
Michael Troyer (NCEA/CIN)
Tim Wade (NHEERL/EPHD)
Gene Whelan (NERL/ERD)
Amina Wilkins (NCEA/WAS)
Susan Yee (NHEERL/GED)
Kathryn Saterson (NHEERL/MI Rep.)
Kevin Summers (NHEERL/NPD Rep.

## 2.62 Community Public Health & Well-being

**Project Number & Title**
2.62 - Community Public Health & Well-being

**Project Lead and Deputy**
Tim Wade – NHEERL (PL); Jim Quackenboss – NERL (PD)

**Project Period**
FY16- FY19

**Project Summary**
An essential component for advancing community sustainability and resilience is access to built and natural environments that protect and promote good health and well-being. Progress towards sustainability at the community level should include community decisions that minimize contaminant exposure and adverse health impacts, while recognizing the need to consider non chemical stressors and community/individual vulnerabilities that can also impact public health.

A main goal of this project is to provide actionable science, decision support tools, and training and guidance so communities can use their limited resources in ways that optimize decisions for protecting and promoting public health and well-being. This project focuses both on facilitating community access to health and exposure assessment tools as well as improving the underlying data (e.g., ecological impact and health risk estimates), associations and assumptions that inform SHC and other EPA decision making tools and models. EPA partners and external stakeholders will be able to assess the implications of their decisions (e.g., development decisions, environmental management or pollution prevention strategies) on community health and well-being, and monitor changes in environmental conditions and public health, including tracking trends for a diverse range of health and well-being measures. Actionable research generated by this project can be used by EPA, other federal partners, academia, community decisions makers, and a range of external stakeholders to protect and promote public health and well-being.

**Project Description**

<u>Problem and Decision Context</u>

In most cases, the actual health and well-being benefits or adverse impacts resulting from decisions and actions that have impacts on communities are not well understood or fully considered. Even when estimates are available, they often do not capture the entire scope or long term impacts on human health and well-being, nor are modifying factors or co-benefits considered. Communities need convenient access to high quality information and tools to enable decision makers and others to educate and inform citizens, and help planners evaluate the health impact of alternative development choices; define their environmental problems; compare decision options to optimize approaches to sustainable environmental health and risk

mitigation; construct and communicate a sustainability framework; and develop and apply relevant metrics or indicators related to community decisions and actions. This project will seek to provide a better understanding of the associations and causal relationships-- as well as quantitative estimates of the relationships--between public health, well-being and ecosystem goods and services which will inform community decisions and improve existing SHC and EPA tools such as Community-Focused Exposure and Risk Screening Tool and Tribal-Focused Environmental Risk and Sustainability Tool (C/T-FERST), EnviroAtlas (http://enviroatlas.epa.gov/enviroatlas/atlas.html), Health Impact Assessments (HIA), EJSCREEN, and Environmental Benefits Mapping and Analysis Program (BenMap, http://www.epa.gov/air/benmap/).

The research and activities in Project 2.62 are designed to:

- Address high priority Program Office and Regional needs related to public health and welfare, such as asthma reduction and mitigation, assessing cumulative impacts, bioavailability research, facilitating training in the use of decision support tools, and evaluating their effectiveness.
- Improve our understanding of the associations and causal relationships between health outcomes, holistic well-being, cumulative risks, the natural and built environments, social and economic conditions at both the individual and community levels.
- Engage and inform Program Office and Regional partners and those making and affected by community-level decisions to reduce environmental health impacts through the application of HIA, Regional Applied Research Efforts (RARE) and Regional Sustainable Environmental Science (RESES) research projects, community interventions, Science to Achieve Results (STAR) grants and training to inform common and impactful decisions, as well as ORD research and tools.
- Improve our understanding of health and well-being-related costs and benefits associated with environmental actions (including improved understanding of causal relationships and cumulative risk).
- Provide human health, exposure and cumulative impact research to improve and expand decision support tools including, but not limited to, HIA, Community Cumulative Assessment Tool (CCAT), C/T-FERST, EnviroAtlas, BenMap, and Decision Analysis for a Sustainable Environment Economy and Society (DASEES).
- Evaluate, ground-truth and provide health context for community indices and models developed in SHC Projects, including the human well-being index and the environmental quality index (EQI) (SHC 2.64) as well as the community typology developed as part of Theme 1 (1.61).

<u>Outputs</u>

2.62.1 Demonstrations of Applying Tools, Methods, and Community Engagement to Mitigate Environmental Health Impacts In At-Risk Communities.

2.62.2 Synthesis of Best Practices Learned from Community Participatory Studies that Address Environmental Health Concerns within Communities.

2.62.3 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.

2.62.4 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.

2.62.5 Enhanced community public health tools (e.g., C/T-FERST) providing access to information for identifying, prioritizing, and addressing environmental health issues in local decision-making.

Focus Areas

*Focus Area #1: Community engagement, assessment tools and decision support tools* - This focus area includes refinement, development, and enhancement of EPA information and tools to help communities and tribes use their limited resources to identify and prioritize risks based on scientific data and analyses balanced with expert community knowledge. These decision support tools and resources include Community-Focused Exposure and Risk Screening Tool and Tribal-Focused Environmental Risk and Sustainability Tool (C/T-FERST), the Community Cumulative Assessment Tool (CCAT), and Health Impact Assessments (HIAs).

C/T-FERST have been developed as resources for community assessment guidance including GIS maps, reports, fact sheets, best practices, and potential solutions. C/T-FERST focus on providing EPA Regions and Programs, Tribal groups, States, other federal agencies, and risk assessment and public health experts working with community groups enhanced access to scientific information and data to facilitate community-based decision-making that protects and fosters human health and well-being. The Community Cumulative Assessment Tool (CCAT) balances the most current research on Cumulative Risk Assessment (CRA) with the principles of stakeholder participation and Environmental Justice. With these tools, communities and tribes can use their limited resources to identify and prioritize risks based on scientific data and analyses balanced with expert community knowledge. Continued research and development activities build on past efforts refining, testing, and applying these tools through collaborations with other ORD research programs, partners and stakeholders; providing training and outreach to EPA Regions and Programs and other users; integrating information on cumulative risk including environmental, social, and economic stressors; and integrating with the EnviroAtlas and other SHC decision support tools. Near-term advances will include improved guidance; identification of uncertainties; and additional data (e.g., healthy food access, PM2.5 and ozone). Longer term efforts will include incorporation of CCAT; enhanced integration with HIA; summarizing and evaluating place-based case studies; developing an internal (EPA) Steering Committee to identify content and functionality needs; integrating tools for citizen science; integrating cumulative risk and vulnerable populations; “what if scenario” capabilities, incorporating results from environmental and exposure models; and applying decision analysis tools. (Outputs 2.62.5, 2.62.3, 2.62.1)

Health Impact Assessments are a growing community engagement and decision support framework that help provide rapid environmental decision support for various sectors, focusing on systems approaches for health and well-being. The Advisory Committee for the National Health Prevention Council has identified HIA as a tool for use by federal agencies to bring a broader public health lens to plans, policies and decisions. Monitoring and evaluation of the effectiveness of HIAs has been limited to impact of the HIA on the decision, plan or policy. Monitoring post implementation of the decision is necessary to fully evaluate the effectiveness of the HIA process on improving public health. EPA has the ability to extend and complement HIAs by integrating sustainability concepts as part of HIA as well as leveraging and applying SHC tools, indicators and indices. EPA is also uniquely positioned to provide improved quantitative information from human exposure science, assessment and monitoring; ecological impact and ecosystem services evaluation; and human health and cumulative risk assessments, and monitoring to improve and validate the estimates and assumptions of HIA. Case studies will provide an opportunity for community engagement (working through OSWER, Program Offices and Regions), refine SHC tools and methods for use by communities, develop training based on community experiences, and characterize best practices and lessons learned. In addition to community case studies, guidance will be developed that includes best practices for a number of engagement strategies. These best practices can be broadly communicated through the C-FERST HIA roadmap and other SHC tools to inform the HIA community of practice. Important federal partners include the CDC for the development of best practices and guidance for HIA use in the federal sector. (Outputs 2.62.1, 2.62.2)

The key products for this focus area include:

*Title:* Pilot case studies and user guidance and training of C/T-FERST
*Description of contribution, form, and use:* Training developed with and provided to regional partners. Manuscripts describing application and effectiveness of C/T-FERST in case studies and lessons learned.
*How products contribute to specific outputs:* 2.62.1 and 2.62.5 showing how SHC tools are used to help communities make better informed decisions
*Product intended end user:* EPA Project Officers in Regions and Program Offices, Tribes, EPA community project leads, ultimately decision-makers and stakeholders in communities

Title: Health Impact Assessments: Case studies and best practices
Description of contribution, form, and use: HIAs of Plans/Policies Related to Transportation, Water and Wastewater Infrastructure and other areas of focus for SHC including plans for Redevelopment Post Hurricane Sandy in the Communities of Long Island; HIA best practices document
How products contribute to specific outputs: Community engagement and training
Product intended end user: EPA scientists and research planners; EPA Regions; Tribes, and community decision makers

*Title:* Synthesis and summary of community health engagement
*Description of contribution, form, and use:* Report summarizing results, best practices and guidance for community engagement
*How products contribute to specific outputs:* Contributes to Synthesis of Best Practices Learned from Community Participatory Studies that Address Environmental Health Concerns within Communities; supports 2.63
*Product intended end user:* Regional and Program staff who work with communities.

*Focus Area #2: Environmental drivers of community health and well being* - This research focus area will improve the understanding of the associations and causal relationships between community health and well-being, ecosystem goods and services and community environmental (including non-chemical) stressors and conditions. Results from this research area will enable EPA to devise, evaluate and advise on effective intervention and prevention strategies, improve risk assessments, inform risk management, and improve public health. The results of this research will also be used to inform SHC tools including EnviroAtlas and C/T-FERST; and BenMAP (Office of Air and Radiation, OAR).

EPA researchers and risk assessors seldom incorporate community stressors such as high levels of poverty, violence, and degraded ecosystem goods and services into assessment of environmental health impacts due to lack of data and/or methods for quantifying impacts of non-chemical stressors on health outcomes. The strain of chronic stress can result in changes at multiple levels including: molecular (e.g., methylation changes in genes), neurological (e.g., hyperactivation of the hypothalamic-pituitary-adrenal axis), systemic (e.g., immune modulation), metabolic (e.g., hormonal changes) and psychiatric (e.g., learning problems). With results from this research it may be possible to reverse some epigenetic changes, avoid metabolic syndrome; and, reduce stressors associated with health by improving the built environment (e.g., green areas to improve walkability and reduce obesity). This research shares objectives with the SHC Project "Assessing Environmental Health Disparities in Vulnerable Groups" (2.63) on the social, environmental, economic, and biological factors that influence vulnerability and health disparities, and research activities evaluating these factors will be coordinated across these two projects. (Outputs 2.62.1, 2.62.2, 2.62.3, 2.62.4) and with the Human Health Risk Assessment (HHRA) research program work on advancing cumulative risk methods.

Sustainability-focused approaches require understanding of the range of cumulative impacts experienced by individuals and communities. Further, individuals respond differently to stressors and vary in susceptibility to environmental insults. Cumulative exposures and individual and community variability are not adequately considered in current exposure and toxicity methods, often due to lack of relevant data. Emerging evidence indicates that social and contextual factors may enhance the toxic effects of both single and multiple environmental contaminant exposures. Conversely, factors of the built and natural environment can advance well-being and mitigate adverse health factors, for example, access to trees and green space can speed healing and diminish anxiety and reduce blood pressure. Research will consider the

interrelationship of diet, behavior, lifestyle, and susceptibility of the cardiovascular, respiratory, and neurological systems to air pollutants. This focus area will integrate results from animal models and observational (epidemiological) studies for cumulative stressors (e.g., obesity) to characterize causal mechanisms and associations for key health endpoints (e.g. diabetes, cardiovascular disease, and asthma). These associations will be further evaluated with population based studies and statistical evaluations. Cumulative risk assessment (CRA) evaluations will be incorporated into C/T-FERST and other SHC tools for community decision making. This focus area shares objectives with SHC 2.63 on factors that influence vulnerability and health disparities, especially long-term effects from early life exposures, and research activities evaluating these factors will be coordinated across the two projects. (Output 2.62.3; 2.62.5)

Establishing generalizable associations between public health and Ecosystem Goods and Services (EGS) can be challenging because communities with degraded EGS are often also adversely impacted by numerous other social and environmental factors. Research will include conceptual diagrams, case-studies, best practices, and identification of data gaps. Findings from EGS-health associations should be replicated in diverse communities for application in cumulative risk assessments (CRA), and to develop meta-analyses to support quantitative effect estimates. Research examples include near-road pollution abatement by tree cover; green space associations with developmental and cognitive effects; severe climatic events (flooding, drought, linkages to ACE and SSWR); and contaminated water (recreational and drinking). Results and findings can be integrated with numerous SHC tools including EnviroAtlas and C/T-FERST; BenMAP (OAR); and community typology (SHC Theme 1). This focus area will integrate closely with the SHC Project "Community-Based Final Ecosystem Goods and Services" (2.61) (Output 2.62.4).

This focus area will include contribution from STAR grants focused on cumulative risk and community impact assessments; and the health impacts and co-benefits (both health and ecological) of land use activities (e.g., urbanization, deforestation, energy production).

The key products for this focus area include:

*Title:* Case studies linking ecosystem goods and services to community public health
*Description of contribution, form, and use:* Manuscripts describing approaches, data requirements and quantitative assessments linking EGS to community public health
*How products contribute to specific outputs:* 2.62.4 (EGS and health)
*Product intended end user:* OSWER, OEJ, EnviroAtlas, Tribes, SHC (C/T-FERST)

*Title:* Cumulative risk case studies
*Description of contribution, form, and use:* Manuscripts assessing changes in response to chemical stressor in the presence or absence of non-chemical stressor(s).
*How products contribute to specific outputs:* 2.62.3 (cumulative risk)
*Product intended end user*: Integration to C-FERST, OAR, HHRA, OEJ

*Title:* Summary of research on methods for assessing combined effects of chemical and non-chemical stressors
*Description of contribution, form, and use:* Report highlighting research developed under seven cumulative risk assessment grants.
*How products contribute to specific outputs:* 2.62.3, methods for cumulative, integrated assessments of chemical and non-chemical stressors.
*Product intended end user:* Regional and Program Office risk assessors, risk managers, OEJ, and community decision makers.

*Focus Area #3: Improving community health, well-being and exposure assessments* - Activities in this focus area will provide improved access to health and exposure data, inform and ground-truth existing SHC tools, as well as explore innovative approaches to better understand and assess environmentally driven community health and well-being conditions.

An immediate research need identified by OSWER is for data on the bioavailability of toxicants in soils. ORD is addressing this by developing approaches to remediate soils used in urban gardening and bioavailability screening tools. Research in this area will continue with the development of rapid, reliable, and inexpensive methods for assessing the bioavailability of metals from contaminated soils and other exposure matrices. This research will evaluate technologies and the bioavailability of metals to determine sustainable remediation technologies that support the efforts of Regions and communities and reduce economic impacts. Sustainable remediation technologies will reduce volumes of contaminated soil sent to hazardous landfills and reduce clean-up costs through efficient use of less intrusive remedial options while ensuring public health-protective cleanups. Research will be used to inform designing urban gardens to safely address healthy food concerns/food deserts in EJ communities. This will help risk managers and risk assessors make better informed decisions about cleanup and safe site reuse in communities, Brownfield sites, and other sites. The focus area will also include working with other SHC projects and ORD programs to refine and apply multimedia environmental and human exposure models, and integrate outputs into C/T-FERST, EnviroAtlas, HIAs and community decision support tools. (Outputs 2.62.1; 2.62.5)

Accurate, quantitative descriptions of environmentally-driven health and well-being conditions are essential in order to understand the impact of national, regional and local community decisions and actions on communities. Activities will include health and well-being data acquisition and descriptions in the form of risk-surfaces, such as local and regional level morbidity and mortality rates related to environmentally associated health outcomes (birth defects, asthma, cardiovascular disease, diabetes) to enhance EPA's existing tools and equip communities and decision makers with better information about the relative costs and benefits associated with community-level decisions. This research area will generate community level health outcome data for incorporation into C/T-FERST and EnviroAtlas and allow improved tracking, modeling and scenario assessment for areas such as climate change, environmental justice, and health disparities. Research will also include evaluation and assessment of health linkages for models, indicators (e.g., Human well-being index, Environmental Quality Index, Community Typology), indices and educational tools (such as the Healthy Heart:

http://www.epa.gov/healthyheart/). As EPA's education programs, indicators and models evolve there is a need to test their impact in shaping decision making and outcomes. Further research may improve the understanding of community actions or EPA regulations on health and well-being. This research will provide a better understanding and quantification of these benefits and will provide inputs for HIAs and Health impact/benefit functions for potential linkage to policy tools such as BenMap. (Outputs 2.62.1, 2.62.2, 2.62.3, 2.62.5)

Innovative surveillance approaches for measuring environmental conditions, exposures, and health and well-being are needed to improve our understanding of chemical and non-chemical stressors on ecosystem and community public health. Application of citizen science, simple indicator-based measures, sensors, or other venues will be explored as a way to inform community exposure and health conditions. These assessment techniques can then be coupled with information about environmental, social, and economic conditions, thereby allowing a holistic assessment of these impacts (both positive and negative) on public health and well-being. There is an important role for biomarkers of exposure/effect to enhance the objectivity and credibility of community health evaluations. Examples include cost-effective and more rapid disease monitoring tools and methods using non-invasive samples (e.g., saliva) to identify the etiologic agents and physiological based measures that identify stress reactions. (Outputs 2.62.1, 2.62.3)

The key products for this focus area include:

*Title:* Evaluation of sustainable remediation technologies related to bioavailability of metals in soils for use in communities.
*Description of contribution, form, and use:* Data and reports will be developed with and provided to Regional and Program office partners on sustainable remediation technologies. Reports and/or manuscripts describing results will be provided for inclusion in C-FERST.
*How products contribute to specific outputs:* 2.62.1 and 2.62.5 showing how SHC tools are used to help Regional/Program offices and communities make better informed decisions.
Product intended end user: decision support tools for EPA Regions and Program Offices.

**Nature of the Work**

The transdisciplinary research proposed in this project includes medical and health expertise; computing resources and software development; spatial and statistical modeling expertise and resources; data use agreements and purchases; sociology and social science expertise; community engagement experience. The nature of the work also includes epidemiology (through existing data analysis, surveys and community biomarker evaluation); exposure modeling and assessment; risk assessment; animal and human toxicology; laboratory science (bioavailability; biomarker assessment); clinical research (enrollment of subjects at the Environmental Public Health Division's nursing station and clinical evaluations); statistical and geospatial analysis (modeling, visualization). This intramural research (and the associated non-STAR funds) will focus on these areas where ORD scientists have particularly significant experience, expertise and interest. The project will be complemented with a significant STAR

component in areas where ORD expertise and experience is less (social sciences, community engagement), with 60% of the total budget allocated to STAR research.

Under the STAR research program, a number of research projects are funded outside of EPA that focus on community public health research and are relevant to Project 2.62. These efforts include ongoing work as well as planned and projected Request for Application (RFAs) and are also captured under the focus areas described above. The ongoing research on methods for cumulative risk/community impacts assessments are specifically linked to outputs 2.62.1 and 2.62.5, and generally relevant to outputs for assessing environmental health disparities and vulnerable populations. The FY15-20 STAR community public health research projects are the results of collaboration across programs and research areas (e.g., ACE and SSWR) to provide the science needed to support community-based decisions. Most communities face complex environmental and public health decisions that may have significant adverse or beneficial impacts on community health, the environment/resources and local and regional economy. The research targets some of the challenges communities face: multiple stressors and their cumulative impacts on human health and ecosystems; integrating community health and ecosystem goods and services and assessing the human health impact and benefits of non-traditional agricultural water resources in rural communities. These community-engaged research projects will contribute collectively to the systems-based knowledge to inform community-level development decisions.

**Collaboration**

Other federal/state/local agencies: CDC (Disease surveillance, biomarkers, burden of disease, and HIA); USDA Forest Service (ecosystem goods and services and health); USDA (community water and health STAR collaboration); local and state health departments (health data acquisition);
Universities: University of Chicago (health data); University of Southern California (asthma); University of California, Berkeley (recreational water, epidemiology, community health); University of South Australia (bioavailability); University of North Carolina (clinical studies, epidemiology and community health); Columbia University (asthma, community health); University of Puerto Rico (asthma); US Department of Housing and Urban Development (asthma, indoor air, mold).
EPA (outside of SHC): EPA Regions (RARE, RESES, HIA; bioavailability); OSWER, OEJ (Cumulative risk, C/T-FERST; bioavailability); OP (community impacts and needs); OAR/OAQPS (BenMap, NATA); OW (NCER RFA, water-reuse, climate change); NCEA & HHRA (Cumulative risk, CCAT, risk assessments, HIAs); SSWR (Risk assessment; virtual beach; EGS benefits assessment); CSS (chemical risks, pathways, human exposure and dose models); EPA Technical Review Workgroup Bioavailability Committee
Planned and/or anticipated collaborations within SHC include: SHC 2.63 (Assessing Environmental Health Disparities in Vulnerable Populations and Lifestages); SHC 2.61 (Community-based Final Ecosystem Goods and Services); SHC 1.62 (EnviroAtlas, integration of air quality modeling with green spaces); SHC 3.61 (Contaminated Sites); SHC 2.64 (Indicators, Indices); SHC 3.61 and 3.62 (linking multimedia environmental and exposure models to decision

support tools); SHC 3.62 (Fuel and oil spills, vapor intrusion); SHC 3.63 ( Sustainable materials management, ingestion and dermal exposures); and SHC 4.61-4.62 (system-based assessment methods).

NCER/STAR:

"Understanding the Role of Nonchemical Stressors and Developing Analytic Methods for Cumulative Risk Assessments" – Ongoing and work to be completed in 2015 related to cumulative risk (http://www.epa.gov/ncer/cra/recipients/index.html)

"Human health impact of non-traditional agricultural water resources in rural communities"- new STAR RFA, in collaboration with United States Department of Agriculture (USDA)

"Integrating community health and well-being and ecosystem goods and services" -new STAR RFA

**Assumptions/Constraints**

Ability to obtain OMB (where needed), IRB and ethical approvals to collect community exposure, human health data, information on community application/impacts of SHC tools, and conduct human health research; Continuation of University of North Carolina cooperative agreements with Centers for Asthma Medicine and Lung Biology; Ability to enroll community participants of sufficient sample size where needed; Ability to obtain community and local health, ecological and environmental data; Approvals to obtain, work with and analyze individually identifiable data when needed; Approvals to access social media data if needed; Expense funding for laboratory work and supplies; Ability to obtain approvals and necessary programming for public web-release of C/T-FERST and other web-based tools; Solicitation and award of NCER grants and RFAs; Key staff with required social science, computational, analytical and community engagement skills

**Project Charter Team Members**

NERL: Barzyk, Timothy; Bradham, Karen; Creed, Jack; Fulk, Florence; Isakov, Vlad; Oshima, Kevin; Quackenboss, James; Schultz, Brad (retired); Vesper, Stephen; Tulve, Nicolle; Xue, Jianping; ; Zartarian, Valerie (MI representative)

NHEERL: Crooks, James; Darney, Sally; Diaz-Sanchez, David; Dye, Janice ; Gallagher, Jane (retired); Gavett, Stephen; Gordon, Christopher; Jackson, Laura; Kodavanti, Urmila; Lobdell, Danelle; Moore, Tanya; Thomas, David; Royland, Joyce; Wade, Tim; Ward, Marsha

NRMRL: Dean, Timothy; Scheckel, Kirk

NCEA: Gwinn, Maureen (Associate NPD); Jarabek, Annie; Lorber, Matthew

NCER: Michaud, Jayne; Payne-Sturges, Devon (retired from EPA)

## 2.63 Assessing Environmental Health Disparities in Vulnerable Groups

**Project Number & Title**

2.63 - Assessing Environmental Health Disparities in Vulnerable Groups

**Project Lead and Deputy**

Lead: Nicolle Tulve, NERL; Deputies: Sally Darney, NHEERL; Maggie Breville, NCER

**Project Period**

FY16-FY19

**Project Summary**

This project will provide data and knowledge about how non-chemical stressors modify chemical exposures leading to changes in health and well-being for susceptible and vulnerable groups. Additionally, aligned with SHC projects 2.61 and 2.62, this project will study the underlying causes of vulnerability in places where people live, learn, play, and work to better understand how community-based decisions influence vulnerability in both positive and negative ways. Foundational and translational research will be conducted in this project to show how non-chemical stressors modify chemical exposures leading to changes in health and well-being. Selected emphasis will be placed in three research focus areas: 1) Children's environmental health: susceptibility and vulnerability associated with early life exposures that set the stage for adult health; 2) Tribal communities: the influence of cultural factors and beliefs that impact environmental quality, health outcomes, and sustainability; and 3) Disproportionately impacted communities: the influence of social and economic factors as modifiers of environmental exposures and associated responses to chemical contaminants, including resiliency at the individual and community levels. These research focus areas will provide data and information to identify and characterize exposures to both chemical and non-chemical stressors, an improved understanding of how non-chemical stressors modify chemical exposures leading to health outcomes, and strategies to reduce exposures to stressors, ultimately improving health and well-being. Research in this project will address four outputs related to these research focus areas. Key products will be used to align research activities with the outputs. Research strategies will be developed that contain research activities and associated deliverables that directly support the key products and outputs. Research in this project will contribute to multiple SHC outputs and outcomes, and inform tool and model development across SHC projects and other ORD national research programs. Stakeholders include decision makers in EPA Programs and Regions; state, local and Tribal governments; and communities, groups, and individuals. Research in this project will contribute priority research as described in ORD's Children's Environmental Health and Environmental Justice Research Roadmaps, which integrate research on these topics that is ongoing in all ORD national research programs.

**Project Description**

Problem and Decision Context

Human health and well-being are inextricably linked to the environment. Implicit in EPA's mission and explicit in multiple Executive Orders and mandates are the needs to consider vulnerable groups in rulemakings and to ensure that EPA's rules do not have a differential impact on communities and do not cause or increase health disparities. Goal 3 of EPA's Strategic Plan addresses cleaning up communities and advancing sustainable development to achieve more livable communities. Additionally, the SHC program is based on the premise that the best way to meet the long-term goals of EPA's mission is to help communities find effective ways to meet federal requirements; to help the Agency and local governments develop regulations and practices that are less expensive and more socially just and acceptable; and, where possible, to provide innovative and effective non-regulatory approaches that equitably protect human health and the natural environment, while advancing sustainability.

We currently do not fully understand how the built, natural, and social environments interact to influence health and well-being across the human lifecourse. 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.

The overall project goal is to understand how non-chemical stressors act as modifiers of chemical exposures, impacting the health and well-being of vulnerable groups.

Outputs

2.63.1: Development of a systems level approach to understanding children's environmental exposures, health and environmental diseases (FY16)
2.63.2: Translational research to incorporate data and information on children's environmental health (CEH) into tools to inform community actions (FY19)
2.63.3: Research to inform Tribal sustainability (FY19)
2.63.4: Evaluation of tested approaches to resolving health disparities in vulnerable populations and lifestages (FY19)

Focus Areas

The three research focus areas for this project are 1) Children's environmental health: susceptibility and vulnerability associated with early life exposures that set the stage for adult health; 2) Tribal communities: the influence of cultural factors and beliefs that impact environmental quality, health outcomes, and sustainability; and, 3) Disproportionately impacted communities: the influence of social and economic factors as modifiers of environmental exposures and associated responses to chemical contaminants, including resiliency at the individual and community levels. These focal areas are aligned with and address problems defined in ORD's Children's Environmental Health and Environmental Justice

Research Roadmaps which are based on research drivers defined by Agency regulatory requirements and stakeholder priorities.

*Focus Area #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 lifecourse. This complexity makes it difficult to assess the extent to which environmental contaminants, relative to other stressors, contribute to health and well-being. Additionally, this complexity confounds decision-making in regards to interventions designed to reduce exposures and improve children's health and well-being. Furthermore, interventions can be in the form of regulatory actions, policies, and community projects at all levels of government (federal, state, Tribal, community [county, city, local municipality]). Metrics to track public health and to evaluate the effectiveness of interventions or remediation must also take spatial scale into account (from home to neighborhood to region to nation-wide). This multi-dimensional complexity calls for a systems approach to inform decisions designed to optimize our community environments (built, natural, social) for the benefit and sustainability of human health, especially for children who are still developing, and environmental integrity.

This need will be met by output 2.63.1 "Development of a systems level approach to understanding children's environmental exposures, health and environmental diseases." This output will draw from a 2015 product to provide a conceptual framework for a systems approach that is specific to children's environments. It incorporates the contributions of and interactions among diverse environmental stressors (chemical and non-chemical) encountered in child-specific environments and lays these out as determinants of health, along with biological, behavioral and social factors both across the lifecourse and across spatial (local to national) scale. Building upon relationships gleaned from a DPSIR (Driving forces-Pressures-State-Impact-Response) model that considers both economic sectors and social drivers as driving forces (Yee et al., 2012), the framework will include ecosystem service benefits such as those depicted in the SHC Eco-Health Relationship Browser (http://www.epa.gov/research/healthscience/browser/introduction.html). This output will also draw from on-going SHC literature syntheses of environmental influences related to children's health conditions such as obesity (Lichtveld et al., in preparation) and neurodevelopmental disorders (Ruiz et al., in preparation) (causative and exacerbating) and recent ORD research findings including foundational research on children's exposure factors, impacts of early life exposures in laboratory (*in vivo* and *in vitro*) models, and results from the ongoing EPA/NIEHS Children's Environmental Health and Disease Prevention Research Centers (Children's Centers) program (http://www.epa.gov/ncer/childrenscenters/).

Key products for output 2.63.1 include a framework containing all components of a systems approach (built, natural, social environments) for characterizing children's health; a relational database summarizing stressor (chemical, environmental, social) and health relationships based on research publications from the Children's Centers; new evidence and mechanisms for (or against) early life exposures associated with good health or disease later in life (derived from

both in-house and the Children's Centers programs); and best practices for community outreach, engagement, and communication stemming from the Children's Centers.

The conceptual framework can be expanded beyond child-specific environments to encompass all environments (built, natural, and social environments) drawing from results of STAR grants investigating the role of non-chemical stressors (http://www.epa.gov/ncer/cra/recipients/index.html) and other SHC research on cumulative community risk (SHC project 2.62). This integrated systems approach will lay out the interactions of the built, natural, and social environments that together contribute to human vulnerability and impact lifelong health and well-being which can then be incorporated into SHC research on cumulative community risk (SHC project 2.62). It is expected that the conceptual framework will help SHC integrate and coordinate the specific research undertaken in project 2.63 with relevant projects across SHC (especially projects 2.61, 2.62) and in other national research programs (e.g., CSS AOP [adverse outcome pathway] project), and provide a holistic context for communicating results to stakeholders.

Research in this focus area will also contribute to output 2.63.2 "Translational research to incorporate data and information on children's environmental health (CEH) into tools to inform community actions." Research on children's exposure factors, coordinated with research using *in vitro* and *in vivo* experimental models, as well as epidemiology studies, will explore potential impacts of early life exposures on child development and later disease risks. In-house research will strategically complement the mechanistic and observational studies underway in the Children's Centers program (http://www.epa.gov/ncer/childrenscenters/). In addition, the STAR Healthy Schools Research Program is designed to understand how environmental exposures associated with school buildings link to health and well-being. This research will link environmental exposures to environmental contaminants that children and pregnant women encounter in their daily lives with social and economic factors and health outcomes and conditions in order to evaluate associations between these factors and children's health and well-being. These associations can then be used to inform the *in vitro* and *in vivo* experimental models to study causation between identified factors and health and well-being. In order to translate new knowledge and methods into SHC tools, relational databases will be created and updated as new publications become available. This is particularly important with respect to the Children's Centers program where one funding cycle ends in 2015 and others extend to 2019 and beyond.

Key products for output 2.63.2 include a relational database summarizing stressor (chemical, environmental, social) and health relationships based on research publications from the Children's Centers; new evidence and mechanisms for (or against) early life exposures associated with good health or disease later in life (derived from both in-house and the Children's Centers programs); and best practices for community outreach, engagement, and communication stemming from the Children's Centers.

*Focus Area #2: Tribal Communities* - Historical events have adversely changed the environments and traditional food sources specific to many Tribal populations (American Indians and Alaska natives), and have negatively impacted Tribal cultural practices, lifeways, and health. For example, environmental degradation and displacement of Tribes from traditional lands led to elimination of traditional foods in the diet and replacement by less healthy alternatives (e.g., from USDA surplus). Simply stated, impaired features of Tribal environments are not supporting previously sustainable and healthy diets and lifestyles. These changes, combined with social stressors, have led to increased incidences of diabetes, high cholesterol, and obesity in many Tribal communities. It follows that Tribal communities may also be more vulnerable and disproportionately impacted by climate change, especially when it disrupts the ability to depend on surrounding ecosystems for food sources, cultural practices, and unique lifestyles.

In an effort to address Tribal environmental, economic and social problems, Native American institutions have recently increased emphasis on restoring and sustaining traditional, healthy lifeways. This will require evaluation of both environmental conditions and the many factors that contribute to disproportionate exposures and health disparities (e.g., availability of healthy food; restoring traditional foods; differences in exposure factors due to lifestyle and economic pressures). Furthermore, Tribal institutions are raising questions about the impacts of climate change on their communities and lifeways (e.g., sea level rise), and are working with EPA to develop tools that they can use to anticipate and adapt to climate change.

Tribes need evidence-based data and tools to help them identify and anticipate potential environmental problems that may result from changes in their environments and societies. SHC is developing such tools in other SHC projects and adapting them to Tribal needs: Tribal-FERST (SHC project 2.62); EnviroAtlas (SHC project 1.62); the Eco-Health Relationship Browser (SHC project 1.62); and the Tribal Well-Being Index (SHC project 2.64). Tribal case studies are using participatory approaches with Tribal communities in an effort to improve and expand the capabilities of these tools by generating data needed to populate the tools. Likewise, SHC research on optimizing health impact assessments (SHC project 2.62) can be applied in Tribal contexts and incorporated into T-FERST and other SHC tools designed to benefit community decision making in general.

Research in this project will complement and extend these efforts and may leverage research activities with projects in other programs (e.g., AQUATOX in SSWR; remote sensing applications in SHC and ACE; landscape ecology modeling and assessment in SHC; SHEDS [Stochastic Human Exposure and Dose Simulation] modeling in CSS) by generating data needed for tool implementation. Specific to this project, the STAR Tribal Science Program will continue to contribute new information and knowledge about Tribal-specific environmental stressors, including changes in the natural environment (climate change) and cumulative exposures encountered in the built environment (indoor air quality), as well as causal linkages to Tribal health and well-being. In-house research is generating fish consumption data, tribal fish tissue assay data, and dietary exposure modeling that can be incorporated into SHC tools. Other information relevant to Tribal concerns may be provided by research on sea level rise modeling, and on properly functioning condition for riparian areas. For example, Tribes need to

understand the consequences of decisions to restore riparian environments, such as removal of dams and channeling of waterways, which could lead to the introduction of new pathogens.

Research in this project, along with related efforts in tool development across SHC, will contribute to output 2.63.3 ("Research to inform Tribal sustainability") by improving our understanding of environmental, economic, and social determinants of Tribal vulnerability, health, and well-being. This research will fill information gaps; help tailor SHC decision support tools to Tribal needs; and, provide approaches for demonstrating the effectiveness of interventions designed to restore Tribal environmental quality and support sustainable Tribal lifeways.

Key products for output 2.63.3 are a relational database summarizing stressors (chemical, environmental, social) and health relationships based on research publications from the Tribal Science program; best practices for community outreach, engagement, and communication stemming from the Tribal Science program and in-house research.

*Focus Area #3: Disproportionately Impacted Communities* - Environmental health disparities are a consequence of multiple factors contributing to vulnerability. Previous work has focused primarily on disproportionate exposure to chemicals and their associated adverse health effects. However, there is a need to expand this area to understand how social determinants (the conditions in which people are born, grow, live, work, and age) of health can lead to health inequities. These conditions are determined by governmental and business decisions, education, and changes in local ecology. They, in turn, result in differences in health-related factors between advantaged and disadvantaged communities. Accordingly, research is needed to elucidate the relative contribution of these decisions and community stressors in driving health disparities. Relevant stressors may include behaviors, attitudes, clinical care, social and economic factors, as well as factors in the built and natural environments. Since environmental stressors often occur together, a key need is to understand how they act in combination with one another, as well as how they combine with non-environmental stressors. Recent guidance from the National Environmental Justice Advisory Council (NEJAC) and EPA's Children's Health Advisory Committee includes recommendations for research on the social determinants of disease and how psychosocial stressors in over-burdened communities may modify sensitivity to the effects of pollution, resulting in health disparities.

Armed with an understanding of the drivers of health disparities, place-based research is needed in order to adequately evaluate strategies for reducing and/or preventing them. Research is being directed towards this end (SHC project 1.61), and will draw from research on health disparities underway in SHC project 2.62 and the Centers of Excellence in Health Disparities program (in this project). These Centers are integrating environmental factors with social factors that together contribute to health disparities, and testing approaches for reducing their negative impacts.

SHC research contributing to output 2.63.4 ("Evaluation of tested approaches to resolving health disparities in vulnerable populations and lifestages") will address disparities in key health

outcomes that are both environmentally and socially mediated. This output also captures research in SHC project 2.62 that identifies community stressors that contribute to key public health outcomes such as asthma and obesity. New research may include epidemiological and/or clinical studies that expand spatial analyses to include social, socioeconomic, or cultural factors; identification of predictive biological markers to aid in the identification of target populations in need of enhanced interventions; animal and other studies that help understand the joint effects of psychosocial stress and environmental contaminant exposures; or, studies to understand the contributions of prenatal exposures common in overburdened communities. Research contributing to this output will assist decision makers in EPA and communities in designing interventions and setting standards to protect at-risk populations.

Key products that address output 2.63.4 include a relational database summarizing stressor (chemical, environmental, social) and health relationships based on research publications from the Centers of Excellence on Environmental and Health Disparities program; case studies demonstrating prevention/mitigation strategies and decision consequences that most impact community decisions; and best practices for community outreach, engagement, and communication stemming from the Health Disparities Centers and in-house place-based studies.

**Nature of the Work**

This work is a combination of ORD intramural research and STAR extramural research. The intramural research effort will focus primarily on children's environmental health research with consideration of factors disproportionately impacting vulnerable groups, and a small effort in Tribal research. The extramural research will focus on children's environmental health research, Tribal research, and disproportionately impacted communities' research. All research efforts involve or draw from both laboratory and field work. It is anticipated that the laboratory work will include *in vitro*, *in vivo* (animal models), and methods development to support field work.

**Collaboration**

As research opportunities are identified, we will explore options for collaboration, especially in regards to place-based studies. We anticipate collaborating with SHC projects 2.61 and 2.62, the CSS AOP project, and SHC projects 3.61, 3.62, and 3.63. The STAR extramural research program is comprised of collaborations with entities both within and outside the Agency, including but not limited to ORD, other EPA program offices and regions, other federal agencies, as well as the grantees who receive the extramural funding and conduct the research.

More information on these collaborations can be found at the listed links:

Children's Centers program: http://epa.gov/ncer/childrenscenters/.
Tribal Science program: http://www.epa.gov/ncer/tribalresearch/.
Centers of Excellence on Environmental and Health Disparities program:
http://www.epa.gov/ncer/ehs/disparities/health-disparities.html

**Assumptions/Constraints**

This project will require access to adequately staffed and stocked in-house laboratories (e.g., genomic, epigenetic, chemical analyses, animal) and ORD expertise in exposure science, toxicology, systems biology, systems thinking, and bioinformatics. Additionally, place-based studies will require expertise in community engagement and sufficient resources for travel and field research. This project would benefit from expertise in social science and social epidemiology which are not currently available in ORD.

It is not clear if needed expertise will be available; however, engaging people currently working in other SHC projects (2.61, 2.62) and national research programs may help fill this need. To add community-based studies as described, current access to statistical and epidemiological support is likely not sufficient. While this project focuses on Tribal vulnerability, Tribal needs extend beyond the scope of this project. A coordinated program, adequately staffed and resourced, would allow for a more comprehensive approach.

**Project Charter Team Members**

Major authors: Nicolle Tulve, James Quackenboss, James Starr, NERL; Brian Chorley, Sally Darney, David Diaz-Sanchez, Chris Lau, NHEERL; Jacky Rosati, NRMRL; Maggie Breville, NCER; Amina Wilkins, NCEA; Ken Bailey, OSP

Contributors: Barbara Abbott, Jane Gallagher, Mary Gilbert, Chris Gordon, Earl Gray, David Herr, Danelle Lobdell, Ginger Moser, Tammy Stoker, Tim Wade, NHEERL; Lisa Melnyk, Marsha Morgan, Elin Ulrich, Steve Vesper, Valerie Zartarian, NERL; Rich Callan, Nica Louie, Cynthia McOliver, Jayne Michaud, NCER; Janet Gamble, NCEA; Maureen Gwinn, SHC Staff

## 2.64 Indicators, Indices and the Report on the Environment

**Project Number & Title**

2.64 - Indicators, Indices and the Report on the Environment

**Project Lead and Deputy**
Lisa M. Smith (NHEERL), Project Lead; Seema Schappelle (NCEA), Deputy Project Lead

**Project Period**
FY16 – FY19

**Project Summary**
SHC 2.64 research will help advance our understanding and communication of the causal relationships between human health, ecosystems, and well-being by evaluating and developing indicators for application to tools that enhance community sustainability. Research will focus on identifying and developing appropriate indicators and indices for community stakeholders to utilize when assessing the broad range of impacts, outcomes, costs and benefits associated with the decision process and post-decision execution in context of protecting human health and the environment and fostering economic growth and human well-being. Through the use of decision support tools, community stakeholders will be better able to assess and predict the interactions between the natural and built environment using scientific knowledge of ecosystem services and health outcomes to promote human health and well-being and maintain or restore environmental quality. Communication and demonstration of the utility of indicators and indices emerging from this research (e.g., Report on the Environment) will provide Program Offices, Regions, and communities a means of interpreting the relationships between ecological condition, environmental quality, and community health and well-being in context of community goals, objectives and decision-making. The indicators and indices developed within the scope of this project will serve as measures to track progress towards sustainability goals.

**Project Description**

<u>Problem and Decision Context</u>

Decision makers need the appropriate indicators and indices to assess, track, and equitably weigh integrated human health, socio-economic, environmental, and ecological factors to foster sustainability in the built and natural environments. This project will accomplish a number of activities to assess the utility of multiple scale indicators for addressing sustainability issues. The current use of indicators and indices within research programs will be cataloged and information gaps will be identified in order to inform the Report on the Environment (ROE), other projects, approaches, and tools across the Agency. The ecological relevance of environmental quality indicators will be systematically evaluated to provide the Agency with a robust set of indicators to measure ecological condition on a broad scale. Additionally, measures of ecosystem condition, human health and well-being will be holistically integrated to address the three pillars of sustainability for use in SHC tools (e.g., Projects 1.61, 1.62 and 4.61). Current and newly developed indicators will be evaluated for their utility in systems approaches for examining sustainable outcomes (e.g., Total Resource Impacts and Outcomes (TRIO)) in order to crosswalk them with other themes in the SHC program. Lastly, the Agency will

produce an enhanced ROE with a trend interpretation component, broadening the utility of the ROE's indicators.

In order to accomplish these activities, the research outlined for this project will address the following science questions:

- How can indicators and indices help decision makers assess final ecosystem goods and services (FEGS), sustainability, climate change, human health and well-being?
- How can ecological, human health and well-being indicators help communities assess sustainability decision options (an important part of defining what's sustainable)?
- How can sustainability indicators help EPA and its partners make decisions about environmental policy, education, and monitoring?
- What is the role of national level indicators in informing community-level indicator development and community-level decisions?
- How can environmental indicators be utilized in decision support tools that evaluate the sustainability of short and long-term community decisions in the context of protecting the environment and public health?

Outputs

2.64.1 Incremental Report on the State of the Practice for Environmental Indicators (FY16)
2.64.2 Provide indicator information necessary for the incorporation of environmental indicators into SHC Decision Support Tools (FY17)
2.64.3 Draft report on the Environment (ROE) -2017 with Interpretation of Trends (FY18)
2.64.4 Incremental Report on the State of the Practice for Environmental Indicators, including Community Sustainability and Indicators of Well-Being (FY19).

Focus Areas

This project has emerged as the evolution of indicators and indices research developed earlier within SHC. This project consolidates previous research focused on (1) reporting the condition of the environment and human health in the United States (formerly SHC 3.4.1 Report on the Environment (ROE)); (2) identifying and creating indicators and indices that inform community sustainability in terms of environment and human health outcomes (Environmental Quality Index (EQI)), provisioning of goods and services and well-being endpoints (Human Well-being Index (HWBI)); (3) demonstration of web-based tools and data bases that help stakeholders identify sustainability indicators relevant to community priorities (Database of Sustainability Indicators and Indices (DOSII), formerly SHC 1.2.2 Provide Indicators and Indices to Assess, Track, and Inform Community Sustainability)); and (4) research supported through the Science To Achieve Results (STAR) program's Environmental Public Health Indicators (EPHI) portfolio of extramural research grants (2.2.1.3 Environmental Public Health Indictors (STAR) Reliable public health indicators linking source to exposure to public health outcomes ).

The existing inventory of indicators has informed and will continue to inform efforts to develop national-level indicators of sustainability for incorporation into the ROE and SHC decision support tools. Combining these project areas creates opportunities for the inclusion of existing and newly developed ecological, environmental public health, human well-being and sustainability indicators into future versions of the ROE. Specifically, this research will support updates and interpretive analyses for the ROE, provide information for incorporation of new and existing indicators into SHC decision support tools and examine human and ecological resilience.

Within the scope of this project, four focus-areas have been identified. Collectively, the research identified will demonstrate holistic approaches for assessing human health and well-being in regards to changes in environmental conditions, ensuring that indicators are transferable to different community types and various spatial scales.

The research objectives within the scope of these focus areas include:

- Catalog the current use of indicators and indices within SHC and other ORD Programs and identify information gaps.
- Determine ecological relevance of environmental quality indicators
- Integrate measures of ecosystem condition and human health and well-being to address holistically the three pillars of sustainability for use in SHC tools.
- Produce ROE with new indicators and trend interpretation.

Focus Area #1: *State of the Practice for Sustainability Indicators* - Assist communities in assessing the sustainability of decision outcomes through communication to EPA program offices and regions, researchers and community stakeholders, the current state of practice for environmental indicators in sustainability research and identify research needed to fill information gaps.

Environmental indicators are useful in determining progress in the protection of the environment and human health. Further, these same indicators may help identify where challenges remain. To assist communities in assessing the sustainability of decision options, it is necessary to communicate to EPA program offices, regions, researchers and community stakeholders, the current state of practice for these indicators and to identify research needed to fill information gaps. Such communication can be achieved through an integrated compendium of indicators and indices, developed through the Sustainable and Healthy Communities (SHC) research program and other indicator research efforts ongoing since FY12 (2.64.1; 2.64.4). These reports will include indicators and indices used to assess ecological condition, ecosystem goods and services, environmental quality (natural and built), climate change, as well as environmental public health and human well-being. Information regarding the utility of these indicators—what they describe, how they are being used and how they could be used—will inform research in the development of SHC decision support tools, such as DASEES, EnviroAtlas, and C-FERST/T-FERST. Relevancy and value will be vetted through research, application and community demonstrations, as addressed in our communication

strategy. Communication across SHC projects will help guide the use of existing indicators and the development of new indicators for holistically addressing a variety of sustain ability issues (2.64.3; 2.64.2). These reports will allow EPA's program offices, regions, and communities to understand the relationship of indicators and indices to community well-being and the impacts of decisions on the community sustainability goals and objectives and provide information regarding the evaluation of current and new indicators for utility in decision support tools.

To better assist communities in assessing sustainable decision options, it is necessary to compile the current state of the practice for these indicators and to identify research needs to fill the information gaps. Research products will communicate research specific to the following:

- Develop an integrated compendium of indicators and indices provided as a synthesis report on the state of the practice for environmental indicators mined from research efforts occurring in FY12 to FY15.
- Develop an integrated compendium of indicators and indices provided as a synthesis report on the state of the practice for environmental indicators mined from research efforts occurring in FY16 to FY19.
- Develop a synthesis report of completed grants under EPA's Science To Achieve Results (STAR) Environmental Public Health Indicators Research.

Focus Area #2: *Development of Indicators of Ecological and Community Resilience*- Advance the field of resilience science by exploring the interdependence of human and natural systems to inform TRIO approaches for community sustainability planning and understanding potential trade-offs.

The concept of sustainability encompasses the need to maintain conditions necessary to support socio-ecological systems while ensuring the persistent provisioning of ecosystem goods and services. Further, it underscores the fact that sustainability is impossible to maintain or achieve without resilience. In simple terms, resilience is the ability of a system to respond to or recover from a disturbance, whether short or long term in nature. In the natural environment, resilience refers to the amount of disturbance required to shift a system from one regime (set of conditions) to another. Human and natural systems typically have inherent resilience and can persist under some external impacts. However, it is possible for the pressure on a system to cross a threshold and reach a tipping point where it loses resilience such that the function and services that system provides may be degraded or completely lost. Understanding regime shifts and identifying measures that provide early warning of transitions is critical to system resilience and therefore, sustainability.

This effort responds to the need for measures, frameworks and management strategies that facilitate conditions necessary to foster social-ecological resilience in the face of patterns of growth, resource use, development and environmental change. Research will advance the field of resilience science by exploring the interdependence of human and natural systems to inform

community sustainability planning (2.64.4 as well as potentially outputs associated with other SHC Projects; e.g., 2.62 and 2.63). Research within this focus area will explore the linkages between sustainability, resilience and environmental change and develop information on qualitative aspects and quantitative measures of resilience to provide guidance to regions and program offices that may contribute to climate change adaptation and the sustainability of ecosystems and communities. These measures will be employed to case study systems to test their ability to assess spatial and temporal trends and tipping points in human and natural system dynamics. The development of these approaches will be the foundation for frameworks to support adaptive management of social-ecological systems and resilience based governance to promote sustainable ecosystem management and inform community planning decisions.

Research products within this focus area will relate social-ecological resilience indicators to sustainability and investigate their utility by evaluating the impact of variations in human and natural systems. These products will communicate research specific to the following:

- Review and compilation of measures for assessing the resilience of human and natural systems.
- Qualitative aspects of resilience that will inform strategies for incorporating resilience, law and policy (to include governance and adaptive management)
- Application of indicators to ecological and human systems to assess system resilience
- Identification of key characteristics of system dynamics to include stability, tipping points, critical transitions and possible drivers useful for planning and management

Focus Area #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 for evaluating the utility of full suites of indicators in the SHC decision support tools, TRIO approaches and ROE.

Indicators provide evidence that certain conditions (environmental, social, economic) exist. Condition indicators need to be combined in a way that provides a means for assessing progress towards desired outputs, outcomes, goals and objectives when considering the sustainability of solutions. In terms of environmental quality, both ecological relevance and human health and well-being endpoints must be evaluated. Ecological condition is reflective of processes and function as well as the provisioning of ecosystem goods and services. Environmental quality, inclusive of the built and natural environments, is inherently linked to economic and social function, all of which have direct and indirect relationships with public health outcomes and core aspects of overall well-being.

The indicators and indices developed under the scope of this project must address the issue of concern and be technically sound, easily understood and accepted by stakeholders. The

construct validity of indicators and indices will be evaluated to make sure that they are robust and meaningful measures of specific issues of concern (i.e., ecological, environmental, human health). Indices and indicators will be evaluated for their ability to respond to changes and be useful for comparisons and tracking progress over time. A key objective of this project is to give interpretation to indicators of environmental quality beyond "good, fair, poor" so that assessments of environmental conditions can be appropriately evaluated in a structured decision context. Environmental conditions will be assessed not only in context of adverse effects, but also in relation to beneficial effects of ecological relevance, public health outcomes and well-being endpoints.

Research will include linking environmental quality to specific public health outcomes (e.g. low birth weight, asthma, obesity), incorporating the EQI into HWBI relationship functions equations, examining the human health domain of the HWBI for applications to vulnerable populations and developing composite indices of ecological condition that characterize the natural environment and its relationship to human well-being at multiple scales. This expanded characterization of environmental quality is essential to the evaluating the utility of full suites of indicators in SHC decision support tools (e.g., DASEES, EnviroAtlas, C-FERST/T-FERST) and will potentially inform trend analysis efforts for the Report on the Environment (2.64.2; 2.64.3; 2.64.4).

Suites of indicators for evaluating the relationship between ecological condition and human health and well-being will provide a better understanding of the ecological relevance of environmental quality indicators. Research products will communicate research specific to the following:

- Analyses of health outcome data in relation to environmental quality at multiple geographic scales
- Modification of HWBI models linking services flows to well-being endpoints using environmental quality parameters (EQI)
- Adaptation of HWBI approaches to selected vulnerable populations with an emphasis on health
- Interpretation regarding the ecological relevance of ecological conditions (from an ecosystem and human perspective) as a holistic measure to be considered in alternative solutions relating to sustainability and resiliency

Focus Area #4: *Report on the Environment* - Evolve the ROE program in both form and substance to meet changing programmatic needs, to respond to new scientific information and to incorporate new indicators researched and developed by SHC and other ORD staff in collaboration with EPA program offices.

EPA's Report on the Environment (ROE) is a comprehensive source of scientific indicators that describe the trends in the nation's environmental and human health condition. The ROE indicators help to answer important questions about the status and historical trends in US air, water, land, human health and exposure, ecological systems, and aspects of sustainability at

the national and regional levels. They provide timely information to help EPA and others make decisions about environmental policy, education, and monitoring priorities. Existing iterations of the ROE have not analyzed or diagnosed the reasons for, and relationships between, the reported trends in stressors and environmental and health outcomes. To fill this information gap and further enhance the utility of the ROE, 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 (including ORD); and 3) develop a new component piece to the ROE that analyzes and interprets the reported trends in a specific topic area (2.64.3; 2.64.4).

The ROE program has been ongoing since 2001 and has evolved in both form and substance to meet changing programmatic needs and to respond to new scientific information and knowledge. Continuing this successful approach, ideas for, and decisions on, new indicators will be developed in conjunction with staff from new and ongoing SHC indicator development and application projects and tasks as well as EPA program offices (2.64.2; 2.64.3; 2.64.4). To ensure the ROE 2018 continues to meet the needs of its users, the specific topics for interpretation will be selected following consultation with the program offices.

Specific products will be produced to support the following areas:

- Develop and maintain a scientifically refreshed and up to date ROE website;
- New indicators developed in conjunction with EPA program/regional offices (including ORD, see other products from this SHC project);
- A component piece to the ROE that analyzes and interprets the reported trends in a specific topic area

**Nature of the Work**

This project anticipates drawing from expertise in the following disciplines.

- Social Scientists (Sociology; Anthropology) (in-house and extramural)
- Economists (in-house and extramural)
- GIS Specialists (extramural)
- Policy Analysts (in-house)
- Epidemiologists (in-house)
- Physical Scientists (in-house)
- Ecologists (in-house)
- Statisticians (in-house and extramural)
- Web-developers (extramural)
- Communication Specialists (in-house and extramural)
- Database Managers (in-house and extramural)
- QA/QC Specialists (in-house)
- Contracting Officer Representatives (in-house)
- Web-services (e.g. geoplatform) ( extramural)

Approximately 15-20% of the work in the focus areas, with the exception of the ROE, will be dependent upon extramural funding for GIS specialists, data purchases, web development, web services, ORISE Post-docs and Student Services Contracts.

Approximately 75% of the proposed work for the ROE is dependent upon extramural funding for technical support contracts and Association of Schools and Programs of Public Health (ASPPH) Fellows through cooperative agreements.

Environmental public health indicators work has already been funded through the STAR Grant Program and FY15-FY19 efforts are related to completion and delivery of associated products.

**Collaboration**

Collaboration with Other SHC Projects

Within the scope of this project, coordination will occur with the Decision Science & Support Tools Team (SHC Project 1.61). This will be done through an exchange of information on methods to calculate indicators and indices of sustainability and well-being within communities (FY 17). Additionally, this project will contribute to next-generation web-based community public health tools that incorporate cumulative exposure and risk research and guidance, additional decision support capabilities, and other user needs identified by case studies and peer review (FY 19). Contributions will also be made to (1.62) the EnviroAtlas, geospatial analysis tool by providing community metrics (FY 17).

There will be collaboration with the Community-Based Ecosystem Goods & Services (EGS) Team (2.61) on their incremental report on the impacts of social (including public health), economic and environmental drivers (particularly climate change), on the production, supply and protection of final ecosystem goods and services (FY 20). Collaboration will also occur with the Community Public Health and Well-Being Team (2.62) by working to enhance community public health tools (e.g., C-FERST) providing access to information for identifying, prioritizing and addressing environmental health issues in local decision-making (FY 19).

This project will contribute to 2.63, Assessing Environmental Health Disparities and Vulnerable Populations by supporting decision-support tools to inform tribal sustainability decisions (FY 18). This project will also collaborate with 3.61, Contaminated Sites and Groundwater on tools for evaluating temporal and spatial impacts of contaminated sites on public health and the environment, for use in site remediation, restoration and revitalization (FY 17), where possible.

Collaboration will occur with the Environmental Releases of Oil and Fuels Team (3.62) on 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 (FY 17). This project will also collaborate with the Sustainable Management of Materials to Support Community Sustainability Team (3.63) on tools for evaluating temporal and spatial impacts of materials

management on public health and the environment, for use in restoration and revitalization decision making (FY 17).

This project will collaborate with the Systems-based Assessment Methods for Community Sustainability Team (4.61) on its interim and updated Guidance for Total Resource Impacts and Outcomes (TRIO) assessment approaches, for use to proactively inform community decisions and advance sustainability (FY 19). The Application of Systems-Level Approaches to Achieve Sustainability Team (4.62) will contribute to this project through seeking to achieve community sustainability by developing a "state of the practice" in using systems approaches in community decision making for sustainable outcomes (FY 19).

Collaboration with Other ORD Research Programs

Coordination and collaboration with other ORD Research Programs will include working with the Air, Climate, and Energy (ACE) program to mine urban resilience indicators and provide additional indicators for consideration to the technical input report on urban area indicators, as well as providing indicators for consideration in the HYGIEIA Model Group.

Collaboration with the Safe and Sustainable Water Resources (SSWR) program includes using indicators developed for aquatic monitoring and assessment and for mapping aquatic condition and watershed integrity. Work with the Chemical Safety for Sustainability (CSS) program includes assessing pesticide usage data to refine environmental quality parameters in EQI models. Additionally, the Homeland Security Research Program (HSRP) will be consulted in developing strategies that are needed to make communities more resilient, including their water systems.

Communication of research and results (web) will be in coordination with the Office of Sustainability, Office of Science Information Management (OSIM) and Office of Environmental Information (OEI).

Collaborations with EPA Program Offices and Regions
Program Office and Regional POCs

- Administrator/Deputy Administrator
- Office of Water (OW): Kitty Miller, Treda Grayson and Sarah Lehmann, Phil Zahreddine
- Office of Sustainable Communities (OSC): TBD
- Office of International and Tribal Affairs (OITA): Bill Sonntag
- Office of Air and Radiation (OAR): Margaret Walters, Randy Waite (OAQPS), Rick Haeuber, Ginger Tennant (OAQPS), Jason Lynch (OAP/CAMD), Mike Kolian (OAP/CCD)
- Office of Solid Waste and Environmental Remediation (OSWER): Brigid Lowery, Maricruz MaGowan, Priscilla Halloran
- Office of Chemical Safety & Pollution Prevention: Jim Cowles, Mark Corbin, David Hrdy
- Office of Children's Health Protection: Gregory Miller

- Office of Policy: Carl Koch, William Nickerson, Beth Termini (R3 & OP), Derry Allen
- Office of Enforcement and Compliance Assurance (OECA): Jessica Aresta-Dasilva
- Region 1: Matt Hoagland, Sarah Levinson, Linda Teuschler
- Region 2: Marie O'Shea, Larry Granite, Alyssa Arcaya, Charles Harewood, Darvene Adams
- Region 3: Nicoletta DiForte
- Region 4: Angie Billups, Anne Keller, Beth Walls, Ravi Rao, Lael Butler (R4/Gulf of Mexico Program), Kristie Friesenhahn
- Region 5: Tom Brody, Lawrence Lehrman
- Region 6: William Rhea, Mike Morton
- Region 7: Brenda Groskinsky, Richard Sumpter
- Region 8: Gerard Bulanowski
- Region 9: Vance Fong, Matthew Small, Eileen Sheehan
- Region 10: Ann Williamson

Collaboration outside of EPA

This project anticipates collaborating with the following stakeholders outside of EPA.

- Office of Management and Budget (OMB)
- Center for Environmental Quality (CEQ)
- Office of Science, Technology and Policy (OSTP)
- Army Corps of Engineers (USACE)
- US Geological Service (USGS)
- Congressional committees
- US citizens
- Communities associated with Tampa, Guanica Bay, San Juan, Gulf of Mexico and Caribbean Community Sustainability, Pacific Northwest, and Great Lakes regions
- Environmental and Social Indicators Consultant (Ainsley Lloyd), Consultant at United States Global Change Research Program
- ARC Centre of Excellence for Coral Reef Studies: Kirsty L. Nash, Nicholas A. J. Graham
- Emory University: Lance Gunderson
- Ezemvelo KZN Wildlife, Louwsberg, South Africa: Chris Barichievy
- National Oceanographic and Atmospheric Administration (NOAA): Craig A. Stow
- U.S. Fish and Wildlife Service: Dean Granholm, Melinda Knutson
- Stockholm Resilience Centre, Stockholm, Sweden: Magnus Nystrom
- Swedish University of Agricultural Sciences: David G. Angeler
- U.S. Geological Survey–Nebraska Cooperative Fish and Wildlife Research Unit: Craig R. Allen
- University of Nebraska: Shana M. Sundstrom
- University of Victoria, British Columbia, Canada: R. John Nelson
- Green 13 - Natural Environment Team of the City of Huntsville, Alabama: Robin Cox
- Department of Environmental Protection, Harrisburg, PA: Huang S. Lin
- Office of Sustainability, City of San Antonio, TX: Bill Barker
- Institute for a Sustainable World, Queen's University Belfast, Northern Ireland: Robin Curry

- Sarasota County Sustainability, Sarasota County, FL: Lee Byron
- Sustainability Program Manager, City of Knoxville, TN: Susanna Sutherland
- Dept. of Decision Sciences, School of Business, The George Washington University: Sanjay Jain
- Fire and Resource Assessment Program, California Department of Forestry and Fire Protection: Justin L. Johnson
- Centre for Well-Being, London: Kaitlyn Gilles
- Senior Water and Environment Consultant, Alexandria, VA: Sharon Murray
- Sustainable Communities and Environmental Services, SRA International, Inc.: Bill Michaud
- University of Florida: Lantz Holtzhower
- Stanford University: Suzan Carmichael
- Texas Department of Health
- CDC Environmental Public Health Tracking Branch
- National Parks Service
- U.S. Forest Service

**Assumptions/Constraints**

The following assumptions relate to the Report on the Environment (ROE).

• ROE program gets a formal, top-down mandate to continue and to formally engage program offices in this effort
• Concept of new ROE work on trend interpretation has formal buy-in and agreement on implementation from Program Offices, including providing appropriate staff, data, and other information to successfully complete the work in the expected time frame
• ROE workgroup is composed of folks with the necessary skills
• Timely internal review by ORD and other involved Program offices
• Timely website guidance from OWC

Assumptions relating to the incorporation of indicators in SHC tools and TRIO approaches are also being made. The indicators and indices developed in this project will be provided for use in multiple SHC tools that have been developed or are in development (e.g., DASEES, EnviroAtlas, C-FERST/T-FERST). The utility of these measures is dependent upon appropriate interpretation of the indicators for use in such tools. The incorporation of these measures into various tools requires a collaborative partnership between this project and the "receiving" projects. Therefore, it is essential that the tool developing projects identify tasks for incorporation of indicators and indices into the tools. Stakeholders can only benefit from this project's research if the tools, of which these indicators are to become a part of, reach the communities. To this extent, demonstration of these tools in a variety of community types with different priorities is vital in order to determine the success of this research and the potential impact as delineated in the following:

• Community stakeholders will use appropriate indicators and indices to inform the methods and tools of decision science and sustainability assessments to frame their decisions.
• Communities will use appropriate indicators and indices to assess the broad range of impacts, outcomes, costs and benefits associated with decisions, including the ability to consider impacts on the environment, economics, and community health in similar terms.

**Project Charter Team Members**

Linda Harwell (NHEERL)
Matt Harwell (NHEERL)
Danelle Lobdell (NHEERL)
Lisa M. Smith (NHEERL)
Tarsha Eason (NRMRL)
Pat Murphy (NCEA)
Seema Schappelle (NCEA)
Tim Buckley (NERL)
Tom Purucker (NERL)
Maggie Breville (NCER)
Kevin Summers (NPD Representative)
Kathryn Saterson (MI-NHEERL)

## 3.61 Contaminated Sites

**Project Number & Title**
3.61 - Contaminated Sites

**Project Lead and Deputy Lead**
David Jewett, NRMRL, Project Lead
Dennis Timberlake, NRMRL, Deputy Project Lead

**Project Period**
FY16 – FY19

**Project Summary**
SHC Project 3.61 emphasizes research and technical support activities and products to characterize and clean up contaminated sites. This project supports the Agency by providing the scientific foundation and technical knowledge for those who engage in Office of Solid Waste and Emergency Response (OSWER)-specific site cleanups and community engagement. Technical support activities will focus on assistance the Office of Research and Development (ORD) provides to OSWER and the Regions in order to characterize and clean up contaminated sites. Technology transfer products will be developed to support remedial project managers and other site management personnel, who then engage communities through the specified procedures. Research activities will address how contamination, from single or multiple sources, can be effectively characterized and optimally remediated to protect community public health and their resources and beneficial uses, and for revitalization and reuse of these sites. Results from this research will provide new and improved methods for characterizing and remediating contaminated ground water, vapors, soils, and sediments to improve community public health and their resources and facilitate revitalization. Research will also address community water supply issues, including environmental justice concerns; providing tools to determine the temporal and spatial impacts of contaminated sites on community public health, including impacts to community drinking water quality and quantity from contaminated ground water, soils, and sediments, and the revitalization and reuse of these sites. A more holistic assessment of community water supplies, one that combines elements of the environment, society, and economy, can be completed by linking predictive tools to mapping-assessments, aquifer vulnerability assessments, water well locations, and economic analyses. This effort 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.

**Project Description**

Problem and Decision Context

Contaminated groundwater is found at 80% of Superfund sites and clean up can take decades to complete. Clean up of contaminated sites is part of EPA's Fiscal Year 2014-2018 Strategic

Plan Goal 3: "Cleaning Up Communities and Advancing Sustainable Development"[1]. Because of the reliance on aquifers for drinking water, the Superfund program seeks to prevent human exposure to contaminants and to try to ensure that ground water quality meets federal and state drinking water standards[2]. As the need for drinking water increases due to population increase, exacerbated by potential cycles of weather extremes due to climate change, contaminated ground water may directly impact people drinking from private wells, limit water supply in some locations, or it may constrain community choices of water supply. Subsurface contamination can be the source of volatile contaminants that enter residences or businesses, also known as vapor intrusion. People may then be subject to inhalation exposure to hazardous pollutants. Discharge of contaminated ground water to surface water bodies may increase contaminant loadings to sediments and to surface water. Superfund sites with contaminated sediments present a risk to surface water and can be a factor in the degradation of beneficial uses through human and ecosystem impairments (for example, fish-consumption advisories). A few contaminated sediment sites are mega-sites where the sediment remedy cost may exceed $50 million[3]. In some cases, ground water/surface water interactions are the mechanism for contaminating surface waters from contaminated sediments. The Federal Brownfields Revitalization Act[4], signed in 2002, was enacted to promote clean up and revitalization of Brownfields. Brownfields are often multimedia challenges with ground water, surface water, soil, and sediment issues.

Health and ecosystem impacts from contaminated ground water, vapor intrusion, and contaminated soils and sediments continue to be reported by the news media. Recently publicized impacts from contaminated sites include negative health impacts from drinking private well water, restrictions on use of ground water for community supplies, vapor intrusion-caused abandonment of office space and legal action over exposure to school children, and contaminated sediments as a cause of fish consumption advisories.

Because of the potential impacts to human health and the environment, the high cost of remediation, the need to support brownfields revitalization, and the impact to community water supplies, this Contaminated Sites research project includes multiple components that 1) provide technical support; 2) conduct research on characterization, remediation and site management; and 3) conduct research on spatial and temporal impacts on community water supplies. Products from these first two areas facilitate Superfund site decision makers through site-specific technical support; and generalized research on hazardous waste site characterization, remediation and site management. The results of this work also supports

[1] Fiscal Year 2014-2018 EPA Strategic Plan, April 10, 2014, United States Environmental Protection Agency, Washington, DC. Goal 3: Cleaning Up Communities and Advancing Sustainable Development. Clean up communities, advance sustainable development, and protect disproportionately impacted low-income and minority communities. Prevent releases of harmful substances and clean up and restore contaminated areas. Objective 3.3: Restore Land. Prepare for and respond to accidental or intentional releases of contaminants and clean up and restore polluted sites for reuse.

[2] http://www.epa.gov/superfund/health/conmedia/gwdocs/brochure.htm.

[3] http://www.epa.gov/superfund/health/conmedia/sediment/index.htm

[4]Small Business Liability Relief and Brownfields Revitalization Act, 115 STAT. 2356.

decision makers at RCRA sites, Brownfields sites, and Great Lakes National Program Office delisting activities with technical products that address assessment and remediation that might be necessary for restoration and revitalization. Products from the third focus area facilitate community decisions on water supplies with respect to Brownfields and Environmental Justice concerns.

Outputs

The Contaminated Sites project is designed to produce products that contribute to five SHC outputs.

- 3.61.1 Lessons learned from ORD's Technical Support to Superfund and other contaminated sites
- 3.61.2 Incremental report on lessons learned from ORD's Technical Support to Superfund and other contaminated sites
- 3.61.3 Methods for characterizing and remediating contaminated ground water, vapor, and sediment sites, impacted with single or multiple contaminants, to improve community public health and their resources and facilitate revitalization
- 3.61.4 Strategies for integrated management of contaminated sites
- 3.61.5 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

Focus Areas

With assistance from the SHC National Program Team, the Contaminated Sites Project Team coordinated with designated staff from OSWER in order to better understand the priorities and needs of this key SHC customer. OSWER staff were engaged through a variety of methods (the SHC Communique, meetings with writing team members, conference calls, and opportunities to review and comment on draft documents). This process of engagement has allowed a greater amount of customer input into the planning process and allowed the project team to better align research and technical assistance activities and key products with customer priorities. Project research and technical support activities are described in the following three focus areas:

1) Technical Support for Contaminated Sites
2) Research on Site Characterization, Remediation, and Management, and
3) Research on Temporal and Spatial Impacts of Contaminated Ground Water with an Emphasis on Impacts to Community Water Supplies.

The exchange of information and ideas between OSWER and the Contaminated Sites Project Team will continue through the project charter development phase. Engagement will also continue throughout the life of the project in order to discuss ongoing research and technical support activities, vet new research and assistance ideas and needs, and adjust to changes in customer priorities to the extent possible.

*Focus Area #1: Technical Support for Contaminated Sites* - Clean ups at Superfund sites are complex processes that involve environmental transport phenomena, remedial decisions, technology implementation, community engagement, remedy review, and redevelopment decision-making. Individual EPA site managers do not usually have expertise in all of these areas and ORD provides support in this area to OSWER and the Regions through five technical support centers: Ground Water, Engineering, Monitoring and Site Characterization, Superfund/Human Health and Ecological Risk Assessment Technical Support Centers[5]. ORD technical assistance can be requested by EPA remedial site managers in any Region as well as program office staff. Center Directors review requests and identify ORD scientists and engineers with knowledge and expertise commensurate with the requests. These technical support centers provide a valuable link between research and contaminated site problems. Knowledge obtained through these activities provides the basis for designing research projects and likewise research provides improved approaches for characterization and remediation of contaminated sites. For example, one priority research area that has been identified by OSWER is mining site remediation. Mining contaminated sites vary greatly in both extent and types of contamination present. ORD's Engineering and Ground Water Technical Support Centers have a long history of working with Regional scientists and staff to address issues related to contaminated mining sites and mining-influenced waters (acid-rock drainage and waters laden with large concentrations of metals and metalloids).

One of the OSWER's primary priorities for the Contaminated Sites project, one that OSWER wants to maintain, is the continued technical support provided by ORD scientists and technical staff to Regional and Program Office staff at Superfund sites across the Nation. Key technical support products will contribute to Outputs 3.61.1 and 3.61.2, which describe technical support activities and compile information on "lessons learned" from this work. These "lessons" capture experience from working on specific sites for site managers and also provide blueprints for future research. In addition, the technical support program greatly enhances state-of-the-science technology transfer between ORD, OSWER, and Regions, providing scientific and technical approaches, methods, technologies, and strategies that are an essential component

[5] http://www.epa.gov/superfund/health/research.htm. Briefly, the Ground Water Technical Support Center provides support on issues regarding subsurface contaminant fluxes to other media (e.g., surface water or air), and ecosystem restoration. The Engineering Technical Support Center offers short- and long-term assistance to Superfund and RCRA Corrective Action staff. Assistance focuses on treatment technologies and engineering approaches to site management at any phase from problem identification through remedial action. The Monitoring and Site Characterization Technical Support Center supports Superfund and RCRA staff with on- and off-site monitoring and site characterization issues. The Human Health and Ecological Risk Assessment Technical Support Centers provide technical information and address scientific questions of concern or interest on topics relevant to ecological risk assessment at hazardous waste sites. When on-site work is required, the TSCs mobilize specialized teams of field scientists equipped with portable or deployable instruments to aid the Regions with screening and site characterization. Expertise is available for support throughout the various stages of evaluation of a site (from planning and design to analysis and data interpretation). The Engineering, Ground Water, and Monitoring and Site Characterization TSCs are supported through SHC Research Program and the Human health and Ecological Risk Assessment TSCs are supported via the HHRA Research Program.

to cleaning up contaminated sites efficiently and effectively. This technical assistance is highly valued by the EPA Regions and OSWER and it will remain a key component of the Contaminated Sites Project. Other key products related to the technical support component of the Contaminated Sites Project are aligned with OSWER priorities, such as the development of tools and technologies to characterize and clean-up Superfund, RCRA, Great Lakes National Program Office Areas of Concern, and Brownfields sites, including site reuse and revitalization.

The key products for Focus Area 1 include:

- Technical support center annual reports: annual reports from the various technical support centers describing assistance activities provided to site managers across the nation.
- Lessons learned: information on lessons learned compiled from technical support activities, capturing site-specific experiences to share with other project managers and providing blueprints for future research.
- Technical support issue papers: issue papers focusing on site characterization or site remediation technologies and strategies (as is current practice, issue paper topics will be coordinated with EPA's Ground water, Engineering, and Federal Facilities Forums, who will provide guidance and input into their development).
- Assessment on the application of geophysical methods to contaminated sites: reports and web site update reviewing the successes and failures of using geophysical methods to map and monitor contamination and remediation.
- Long-term monitoring methods, metrics, and protocols to conduct effectiveness assessments following contaminated sediment remediation and restoration activities in a watershed (or area of contamination, AOC): methods, models, and guidance to characterize the spatial and temporal recovery of watershed and contaminated sediment resources; and report on case studies (from SHC Project 2.62 place-based studies) demonstrating use of methods and models to characterize restoration following remediation and restoration activities in a watershed to support sustainable use of a beneficial resource.
- Contaminated mine site remediation, treatment, and reclamation: compilation of ORD research and state-of-the-practice to assess remediation and treatment technologies for contaminated mine sites and mine influenced waters (MIW); to inform and broaden acceptance of innovative technologies for remediating or treating contaminated mine sites and MIW nationally.

*Focus Area #2: Research on Site Characterization, Remediation, and Management* - Research in this focus area will advance the science and engineering needed for proper assessment, remediation, and reuse of contaminated sites. In some areas, technical knowledge gaps are addressed by developing our understanding of site characterization, remediation, and site management. In other areas, new approaches build upon prior ORD work, such as the impacts of diffusion from fine-grained sediments at in-situ chemical oxidation sites. This research will support site redevelopment and reuse. Technical issues at many sites can be complex, even at

the stage of redevelopment. Characterization, remediation and site management activities continue to play a role when the transition is made to a Brownfields redevelopment or a Great Lakes Area of Concern delisting and restoration which may be a part of a broader community revitalization effort.

OSWER priorities for ground water research include: improving the application and interpretation of high resolution ground water characterization technologies (such as modeling and geophysical tools); conducting research on site characterization and mitigation involving ground water contamination via back diffusion; and developing and evaluating improvements in ground water treatment delivery and extraction technologies and strategies. This focus area targets contaminated ground water research activities that produce important products to address these priorities. EPA publications and papers in scientific and technical journals will be major products of this focus area. In addition to manuscripts for scientific and technical journals, technology transfer products (reports, manuals, tools, models, etc) will be developed that provide the detail necessary to put these products to work, cleaning up our contaminated sites. Several reports and publications are proposed for contaminated ground water research activities; such as, geophysical assessment of monitored natural attenuation; flux-based site management; impacts of multiple treatment technologies; back-diffusion of contaminants from fine-grained materials to conductive aquifers; dense non-aqueous phase liquid source zone and plume response; uncertainty in pump-and-treat and monitored natural attenuation; and related modeling approaches.

Research on ground water will include the application and interpretation of high resolution groundwater characterization technologies and methodologies. ORD, in collaboration with OSWER and the Regions will develop an issue paper on analysis of existing commercially available approaches for high resolution ground water characterization and interpretation to assist Regions.

ORD modeling work will be incorporated with advanced source term characterization to better understand contaminant behavior which can contribute to better site management. ORD will also conduct research on site characterization and mitigation involving plume persistence due to back diffusion[6]. Back diffusion continues to present challenges for the effectiveness of treatment systems and the ability to develop effective exit strategies for site cleanups. Better understanding the diffusion issues as well as developing technologies and high resolution approaches to characterizing sites is essential for effective and protective cleanup of Superfund sites.

Ground water research will continue to develop and evaluate improvements in groundwater treatment delivery and extraction technologies and strategies. As improved source zone and groundwater treatment is contingent on the ability to deliver treatment amendments and extract contamination from the subsurface, this research will support the development of

[6] Back diffusion is the process where contaminants contained in low permeability aquifer materials diffuse into otherwise remediated aquifers.

needed data on the effectiveness of available delivery and extraction systems and ways to improve their effectiveness. Ground water research also focuses on improving treatment technologies and strategies to clean up contaminated subsurface environments. Even though many technologies have been developed to help clean up contaminated ground water, more research is needed in order to improve the efficacy and cost-effectiveness of these technologies, as well as provide new, novel combined treatment technology alternatives. ORD is building collaborations with other organizations, such as the U.S. Departments of Defense and Energy, and the Chinese Ministry of Science and Technology, to improve and optimize remediation technologies for contaminated soils and ground water and to better understand remediation and its impacts on bioavailability/bioaccumulation in soils polluted by heavy metals or PAHs.

The development of an environmental leaching assessment framework for organic pollutants also is a priority for the OSWER. A leaching assessment framework has been developed for inorganic pollutants, the Leaching Environmental Assessment Framework, but a similar framework approach has not been developed for organic contaminants. OSWER and ORD need to further discuss this effort

OSWER priorities for contaminated sediments research include: improving our understanding of linkages between contaminant concentrations in sediment and fish tissue concentrations; improving analytical technology for the evaluation of hydrophobic organic contaminants and metals in soil and sediment; and evaluating the effectiveness of contaminated sediment remediation alternatives and their associated impacts. ORD research on sediments will focus on developing methods and approaches to characterize sources, evaluate remediation technologies, evaluations of remediation and restoration activities, and metrics to measure revitalization and redevelopment efforts. These approaches include techniques such as: deriving sediment interstitial water remediation goals to protect benthic organisms from toxicity, and how interstitial water measurement can be integrated into the prediction of residues in fish. Additionally, research will continue on the use of passive sampling for measuring interstitial water concentrations for contaminants at contaminated sediment sites to help standardize passive sampling techniques and develop rapid evaluation techniques for sediment contaminants. This work will improve the analytical technology for the evaluation of hydrophobic organic contaminants and metals in sediment and in sediment pore water and serve in the development of guidance to apply this new data within the site characterization and remedy effectiveness assessment process. Regarding remedy effectiveness of sediments, ORD will work with OSWER and the Great Lakes National Program Office to evaluate the effectiveness of various remediation processes. As an example, evaluating monitored natural recovery, enhanced monitored natural recovery, amendments, capping, and dredging to meet Remedial Action Objectives at Superfund sites and Great Lakes National Program Office Area of Concern sites, and to evaluate the efficacy of remedy and restoration activities. ORD will work with OSWER, the Regions, and the Great Lakes National Program Office in developing a potential inter-agency effort to better understand the linkages between sediment and fish tissue concentrations of PCBs, PAHs, dioxins, Me-Hg and Hg, and metals.

Additional discussions between ORD and Program Offices, including the possibility of a technical workshop that includes academia, may help elucidate linkages between pollutant concentrations in sediments/pore waters and those in fish tissue. Case studies from place-based research sites and other contaminated sediments sites will demonstrate methods and approaches for characterizing sources of contamination to aquatic sediments sites from point, non-point, groundwater, and upstream sources. Additionally, these case studies will provide long term monitoring methods and protocols to characterize restoration following remediation activities in a watershed to support sustainable use of resources and to assess remediation to restoration to revitalization (R2R2R).

ORD is designing its vapor intrusion research activities to address OSWER requests for information on 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. Research on vapor intrusion will also include a literature review on the influence of building parameters on vapor intrusion (for example, the role of building physics in indoor air concentration, and the influence of building efficiency on vapor intrusion). Addressing this priority also will allow scientists to describe the defining characteristics of vapor intrusion problems to guide site assessments and model development. Further collaborative efforts between ORD and OSWER and the Regions will include assessment of tools to understand worst case exposure conditions to be able to provide answers quickly and efficiently. Other ORD research and technical support activities will address OSWER priorities on developing short-duration screening methods; improving subsurface characterization, including sub-slab sampling, to quantify contaminant concentrations in soil gas; and ensuring health protection from vapor intrusion is based on accurate predictions. ORD and OSWER representatives are discussing research activities related to assessing and mitigating vapor intrusion in large buildings and the role of soil vapor extraction. Ongoing discussions with OSWER will help to better focus ORD vapor intrusion research activities to ensure that they address the highest OSWER priorities.

Note that future reductions in contaminated sediment and vapor intrusion research will likely accompany any future reductions in FTE for this research area.

Products in this focus area contribute to outputs 3.61.3 and 3.61.4. These proposed products address several of the OSWER's priorities for ground water (site characterization and remediation), sediments (site characterization and remediation, and bioavailability), and vapor intrusion (assessment and remediation efficacy). The work supports management of Superfund, RCRA, and Great Lakes National Program Office Area of Concern sites and additional work which may be needed for Brownfields revitalization.

The key products for Focus Area 2 include:

- Natural attenuation of metalloids: report addressing transport and fate of metalloids and their management through natural attenuation remedies.

- Mobilization of metals - report extending prior work on metals to address conditions under which metals become mobilized, including transformations of organic co-contamination.
- Post-in situ chemical oxidation assessment of VOC rebound, impact of natural attenuation, and changes in aquifer permeability: product evaluating the influence of ISCO on VOC rebound (back diffusion), natural attenuation capacity, and aquifer characteristics following ISCO treatment at a contaminated case study site.
- Critical analysis of pore volume estimation methods for designing ISCO oxidant loading: critical analysis of ISCO design factors used in estimating the delivery of oxidant volume/dosage.
- Flux-based site management: report on aspects of fluxed-based site management (selection of monitoring points, uncertainty in complex aquifers, application) and economic analysis at a contaminated case study site.
- Back-diffusion assessment and management strategies: products focusing on magnitude and significance of back-diffusion for site characterization and management and evaluating strategies for managing risk due to back diffusion.
- Analytical models for two- and three-dimensional contaminant transport in aquifers characterized by low- and high-permeability zones: tool for predicting contaminant distribution at contaminated sites characterized by preferential pathways (high-permeability layers) interacting with surrounding, low-permeability zones.
- Using geophysical methods to map, characterize, and monitor contaminant plume location and movement in the subsurface: guidance documents and reports on geophysical methods for contaminate plume mapping and remedy monitoring; literature review of geophysical methods best practices for characterizing contaminant plumes directly and indirectly through their interaction with natural subsurface conditions, and research on geophysical methods as a proxy for monitoring active and passive remediation efforts.
- Tools to characterize and monitor groundwater-surface water interactions: products testing, developing, and assessing field investigative tools such as fiber optic distributed temperature systems (DTS) and electrical resistivity for this purpose.
- Applications of passive sampling for measuring interstitial water concentrations of contaminants of concern at contaminated sediment sites: research products evaluating: 1-passive sampling methodologies for estimating bioavailable concentrations of contaminants in sediments and the water column, and 2-the efficacy of passive sampler-based interstitial water measurements to improve predictions of contaminant concentrations in fish and shellfish.
- Improving bioaccumulation models for predicting residues at contaminated sediment sites: determination of processes causing the apparent increase in bioaccumulation as concentrations in sediments decrease at Superfund sites with contaminated sediments.
- Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates: revised sediment testing methodologies that are used by testing laboratories (private and governmental) across the country and globally.
- Develop and demonstrate methods along multiple lines of evidence for site characterization used in source identification/apportionment, remedial investigation, and feasibility studies: case studies from place based research sites (e.g. SF and AOC projects) demonstrating the

use of multiple lines of evidence (chemical, biological, physical, and modeling) for source and site characterization and effectiveness assessment.

- Calibrated hydrodynamic model simulating sediment and metals mass flux in aquatic systems: an Environmental Fluid Dynamics Code (EFDC)-based model that will work in concert with a previously delivered watershed loading model (SWAT) to simulate fate, transport, and sediment-water interaction of contaminated sediment facilitating remedy evaluation in RI/FS studies.
- Development of a conceptual model for vapor intrusion using the most current state of knowledge: product defining characteristics of vapor intrusion problems to guide site assessments and numerical model development.
- Analytical solutions for subsurface vapor transport incorporating the mass exchange between vadose zone and water table aquifer: SERDP-leveraged model study that simulates the fate and transport of volatile organic compounds in the vadose zone above the water table aquifer.
- Analytical modeling of soil vapor extraction subject to effective diffusion in a water table aquifer: SERDP-leveraged modeling study that couples the soil-vapor extraction process with lateral diffusion in the underlying ground water.

*Focus Area #3: Research on Temporal and Spatial Impacts of Contaminated Ground Water - Site Reuse and Revitalization and Environmental Justice* - With population increases and increased frequency of extreme weather events due to climate change, there are stresses on aquifer-based water supplies, and the impacts of contaminated sites may constrain community decisions on water supplies. At the decision-making level environmental considerations (Focus Areas One and Two) are augmented by social and economic factors. In Focus Area Three, the temporal and spatial changes in ground water, vapor intrusion and contaminated sediments are coupled with social and economic factors related to community water supplies addressing Environmental Justice concerns and Brownfields needs.

Ground water modeling approaches for both detailed and screening of impacts of contaminated sites are proposed, as are mapping-based evaluation of locations and impacts to private drinking water wells in the context of aquifer vulnerability. These efforts address the environmental pillar of sustainability. This research includes a proposed product that focuses on the economic valuation of various water supply alternatives. This economic valuation of water supply alternatives will be applied to select communities (that is, demonstration projects) as determined by project stakeholders. Combining all of these research components into a demonstration project incorporates the social and economic pillars of sustainability.

The research products in this focus area will contribute to output 3.61.5 by combining knowledge and tools generated to assess community decisions on water supply. These include 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.

The key products for Focus Area 3 include:

- Extension of streamline-based ground water model for management alternatives: extended modeling system that accommodates remedial and site management activity products from Focus Area Two (potential includes reactive barrier walls, monitored natural attenuation, back diffusion, and in-situ chemical treatment).
- Analytical modeling for transport of volatile organic compounds in vadose zone and water table aquifer incorporating mass exchange through air boundary layer near ground: a group of analytical solutions for the equation system describing transport of volatile organic compound in the vadose zone and water table aquifer; the model will specifically accounts for different transport mechanisms in the subsurface domains.
- GIS-based tool for assessment of groundwater contamination to predict spatial and temporal distribution of organic chemicals in groundwater at multiple scales.
- Economic evaluation of water supply alternatives, including an evaluation report addressing impacts of contaminated ground water on choices for community water supplies

**Nature of the Work**

Technical support activities use FTEs for evaluation of site-specific documents and on-site field activities; extramural funds are used to augment in-house expertise in specific areas. ORD and contract personnel will provide support for field work and sample analyses for individual sites. Contaminated site research is divided among laboratory studies, field studies, model development and application, mapping, and economic analysis. The fundamental knowledge of contaminant behavior is developed from laboratory and field studies, and an emphasis is placed on these activities. Field and laboratory studies can also be expensive given their use of supplies and equipment, and the need to staff sites where research and data collection are occurring; hence more of the expense/extramural resources are devoted to these areas. Field research efforts are leveraged with ongoing characterization and remediation site activities. Modeling consumes less physical materials, but requires labor hours, which we obtain mainly through ORD researchers. Mapping and economic analysis, similarly, require mostly ORD personnel.

**Collaboration**

Collaboration within SHC: Decision-making for Superfund cleanups and other remediation, restoration, and revitalization activities is closely related and in some cases integrated with Project 1.61. Contaminant fate and transport research and technical support, as well as other remediation, restoration, and revitalization activities, provide foundations for work in Project 2.62 (Community Public Health and Well-Being). Work on contaminated sites includes impacts to vulnerable populations (Project 2.63 Assessing Environmental Health Disparities in Vulnerable groups) as they may be more severely affected than others. Private well mapping, field data evaluation and modeling, and GIS evaluation of impacts contributes to objectives of: EnviroAtlas: A Geospatial Analysis Tool (Project 1.62); Community Public Health and Well-Being (bioavailability and C-FERST, 2.62); and Environmental Releases of Oil and Fuels (3.62). Development of ground water indices supports Project 2.64 (Indicators, Indices and Report on

the Environment). Ground water transport and contaminated sediments research provides inputs to Project 2.61 for characterizing linkages between Ecosystem Good and Services (FEGS) and public health. Ground water modeling at contaminated sites supports similar needs in Project 3.62 (Environmental Releases of Oil and Fuels). Sediment and ground water restoration research supports Remediation to Restoration to Revitalization (R2R2R) work in Projects 2.61 and 2.63. Tools developed to assess transport and transformation of contaminants provide building blocks for sustainability assessments in Systems-Based Assessment Methods for Community Sustainability research (Project 4.61).

Collaboration with other ORD National Programs: Research on drinking water resources meshes with the SSWR research areas on Watershed Sustainability, Green Infrastructure, and Water Systems. Research on community ground water impacts is applicable to ACE interests on climate change.

Collaboration within EPA: EPA's OSWER and Regions, the Great Lakes National Program Office (Great Lakes Legacy Act and Great Lakes Restoration Initiative), and the EPA's Ground Water, Engineering, and Federal Facilities Forums are anticipated collaborators on contaminated site related research. Additionally, OW is interested in the research related to ground water and potential water quality impacts from contaminated sites. Lastly, this research supports the Office of Sustainable Communities, Children's Health, and Environmental Justice.

External Collaboration: Existing and future external research collaboration will be with other federal agencies (DOD, DOE, NOAA, USFW, USGS); tribal and state regulatory authorities; the Federal Facilities Forum of the Environmental Council of the States; the Federal Remediation Technologies Roundtable; the Interstate Technology Regulatory Commission; the Strategic Environmental Research and Development Program /Environmental Security Technology Certification Program (SERDP/ESTCP); and academic institutions.

International Collaboration: The collaborative research proposed in the work plan to the ORD-Chinese Ministry of Science and Technology Memorandum of Understanding has a strong relationship with SHC Project 3.61 - Contaminated Sites. This relationship is strongest related to Focus Area 2 research (research on site characterization, remediation, and management). ORD and Chinese scientists will work collaboratively to advance the science and engineering needed for proper assessment, remediation, and reuse of contaminated sites.

Key Equipment:

Field sampling equipment (drilling rigs and hydraulic push units, geophysical tools, GPS systems, flux meters, specialized remedial treatment equipment, mobile laboratory, pumps, boats, coring platforms, mobile laboratories, water quality monitoring equipment) and analytical laboratories/laboratory equipment (gas chromatographs, mass spectrometers, flame ionization detectors, electron capture detectors, general water quality parameter equipment, scanning electron microscope, high pressure liquid chromatographs, inductively coupled plasma mass spectrometer).

Key Expertise:

All key expertise required of SHC Project 3.61 are anticipated to be available in-house (ORD) or through one of our anticipated research collaborators.

**Assumptions/Constraints**

Much of the research and technical support is predicated on the assumption that access to suitable sites and data remain available. For our areas of historic focus, no problems are anticipated. For Focus Area Three, the work is extended to communities: selection and participation from appropriate communities is critical to success and will be coordinated with the Regions, States and communities.

**Project Charter Writing Team Members**

Souhail Al-Abed, NRMRL
Steven Acree, NRMRL
Karen Bradham, NHEERL
Barbara Bergen, NHEERL
Michael Brooks, NRMRL
David Burden, NRMRL
Robert Burgess, NHEERL
Lawrence Burkhard, NHEERL
Mark Cantwell, NHEERL
David Carson, NRMRL
Brian Dyson, NRMRL
Robert Ford, NRMRL
Tim Gleason, NHEERL
Mohamed Hantush, NRMRL
Dale Hoff, NHEERL
Scott Huling, NRMRL
David Jewett, NRMRL, Project Lead
Fran Kremer, NPD Representative
Jim Lazorchak, NERL
Todd Luxton, NRMRL
John McKernan, NRMRL
Marc Mills, NRMRL
Dave Mount, NHEERL
Randy Parker, NRMRL, Former MI
Kirk Scheckel, NRMRL
Dennis Timberlake, NRMRL, Deputy Lead
Thabet Tolaymet, NRMRL, Acting MI
Brian Schumacher, NERL
Varma Rajender, NRMRL
Jim Weaver, NRMRL, Former Project Lead
Dale Werkema, NERL
Rick Wilkin, NRMRL
Lynn Wood, NRMRL
Tony Zimmer, NRMRL
John Zimmerman, NERL

## 3.62 Environmental Releases of Oils and Fuels

**Project Number & Title**

3.62 - Environmental Releases of Oils and Fuels

**Project Lead and Deputy**

Robyn Conmy, NRMRL (Project Lead)
Jim Weaver, NRMRL (Deputy)

**Project Period**

FY16 – FY 19

**Project Summary**

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, potentially affecting human health and the environment though their impacts on water quality (including drinking water supplies), or through direct human exposure to toxic constituents. The project is divided into three focus areas: oil spill science and response, leaking underground storage tank (LUST) science and management, and the impacts to community public health and ecosystems. Research on oil spills and leaking underground storage tanks will be used by the Office of Solid Waste and Emergency Response (Office of Underground Storage Tanks (OUST) and Office of Emergency Management (OEM)) and Office of Water to develop guidance and rulemaking with respect to preparation for and response to releases. In addition to the Agency Program Offices and Regions, research for this charter is conducted in support of States, Tribes and, other regulatory authorities. For oil spill science and response, new protocols for chemical agents and other additives, developed by ORD, will be used to inform regulatory actions and guidance. The private sector will use these protocols to advance remediation / response technologies for various conditions and oil products. Also, a portion of impact assessment may be conducted through NRDA (Natural Resource Damage Assessment) and RESTORE Act (Resources and Ecosystems Sustainability, Tourism Opportunities and Revived Economy of the Gulf Coast) efforts. Research on the fate and transport of fuels and their constituents, using laboratory, field, and modeling approaches will be used to reduce the backlog of LUST sites. Research will address ways to improve our ability to minimize environmental and human impacts from these environmental releases.

**Project Description**

Problem and Decision Context

Innovative research approaches described within the SHC 3.62 Charter (Environmental Releases of Oils, including Fuels) help to achieve more efficient and effective management of oil spills, including fuel. Research products allow for the development of improved protocol and guidelines to improve regulations and response efforts to protect communities from exposures to

environmental releases of oils and fuels. ORD provides critical products to OUST and OEM, where key science questions include:

- What response products and actions are effective on oil spills in a wide range of environmental settings to minimize environmental and human consequences?
- What management, assessment and/or remediation approaches are needed for minimizing environmental damage and human and ecological exposures from leaking underground storage tanks?

The overarching project goals are to (1) develop decision-support tools (e.g., models) for determining risk to communities from fuel and oil spills and leaking storage tanks, (2) develop methods and protocols in support of the National Contingency Plan (NCP), including for testing of chemical agents and other additives listed on the Product Schedule, and (3) develop new approaches and tools for evaluating exposure to populations and ecosystems and subsequent impact to communities. We aim for research products to be incorporated into efforts within the SHC program, EPA Program Offices, Regions and community stakeholders addressing and providing sustainable solutions for managing environmental releases of fuels and oils. Measures of success would be reflected in the application of these research products during decision-making activities, including planning.

Outputs

3.62.1 Tools for improved characterization, response and remediation of oil and fuels, to improve emergency response and other cleanup activities; expected completion date: FY 16
Science question: How can we better characterize, respond to, and remediate contamination from new as well as existing fuels and oils to minimize human exposures and environmental damage?
Description: This output will provide new conceptual and predictive tools to characterize and remediate contamination by fuels, and will also provide biological and chemical treatment approaches to improve effectiveness and timeliness of oil spill response and cleanup activities. Conceptual and predictive tools to assist in triaging sites for cleanup and the development of tools to protect community public health and reduce impacts to community resources so site remediation decisions can be more effective and timely. This work will advance community sustainability, especially by protecting and restoring water resources and ecosystems that have been impacted or contaminated by oil, benefitting public health and environmental resources. This effort will build on previous work with fuel and oil contamination, with attention to newer types of fuels and oils, and the environments in which they will be present.

3.62.2 Tools for evaluating temporal and spatial impacts of fuels/oils site cleanup on public health and the environment, for use in oil spill response and in site remediation, restoration and revitalization; expected completion date: FY17
Science question: How can we better determine the type, degree and extent of impacts of fuel and oils spills on community public health and their resources, especially those that are temporally and spatially removed from the original contamination?

Description: This output will provide tools to help communities and site managers to better evaluate and predict the potential public health impacts of fuels and oil spills, so they can identify and address those impacts to advance public health through prevention measures and improved response technologies to minimize impacts to their resources. This effort will build on previous contaminant fate and transport characterization work, which is necessary to evaluate exposure to populations and impacts to ecosystem services that will affect human health and the environment. This will involve assessment of appropriate metrics for oil spill response, and for remediation, restoration, and revitalization, in the context of potential changes due to various factors, such as climate change.

Focus Areas

*Focus Area #1: Oil Spills* - Atypical oil spills (e.g., deep sea and prolonged), such as the 2010 Deepwater Horizon (DWH) Gulf of Mexico spill, have resulted in heightened awareness by emergency responders and scientists, on both the capabilities and limitations of the spill response methods available for use today (viz., conventional booming and skimming, *in-situ* burning, bioremediation, and the application of dispersants), but also on the equally important ecological and human health concerns associated with certain spill mitigation technologies[7]. Ecological issues concerning dispersant and dispersed oil toxicity on deep sea and surface flora and fauna, their ultimate fate in the environment, and the effects of chemical agent use on oil impacted shorelines and wetlands are of concern. These concerns are expressed by not only Federal, state and local governments but also by the impacted communities, especially those who rely on aquatic resources for their livelihood (e.g. fishermen). Additionally, smaller spills occur throughout the country (over land and inland waters), also have similar human health, ecological, and economic concerns for impacted communities. Research related to oil spills will focus on at least two aspects of 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:

- Develop a better understanding of the impacts of oil spills and dispersants application on the environment.
- Develop a better understanding of the environmental impacts of oil spills, including non-petroleum oils, on coastal (including shoreline) and inland environments.
- Develop innovative and more sustainable technologies to assess and mitigate the impact of oil spills.

Oil Spill Emerging Issue: The shipment of oils across the U.S. to refineries has drastically increased in recent years (e.g., Midwest to the Gulf of Mexico shipment via the Mississippi River is up 13-

[7] Report to the President: *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling,* National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling http://www.oilspillcommission.gov/sites/default/files/documents/DEEPWATER_ReporttothePresident_FINAL.pdf

fold since 2010, monthly barge and tanker shipment to the Gulf Coast is now ~3.8 million barrels) (source Wall Street Journal, 02/02/14. Additionally, 75% of the oil from the Bakken formation is transported via rail, of which 25% ships through the emerging Albany, N.Y. hub for subsequent delivery to refineries. This doubled the volume of crude bound for Atlantic coast in 2013 (source: NY Times; 02/28/14). These rail lines traverse lands within the Great Lakes watershed. Not only is the increased volume of concern, but also the change in oil type, where diluted and synthetic bitumen is produced from the Bakken Formation and Canadian oil sands formations. These products are particularly difficult to remediate and exhibit chemical and physical behavior unlike other crude oils. Research is needed on the characterization of the oil composition, and on its fate and transport to establish appropriate response and remediation methods.
The key products for the oil spill focus area include:

- Report on the evaluation of optimum mixing speeds for OEM's proposed Baffled Flask Test for the dispersant effectiveness protocol.
- Report on the development of a Surface Washing Agent effectiveness protocol for products on the NCP Schedule.
- Documented approach on the development of a fluorescence library for petroleum oils.
- Report on wave tank simulations characterizing the effect of dispersant on dispersion effectiveness during surface and deep ocean oil spills; a decision support tool.
- Report on the biodegradation and toxicity of diluted bitumen crude oils to determine fate of bitumen discharged in water.
- Propose an efficacy test protocol for solidifiers listed on the NCP Product Schedule.

*Focus Area #2: LUST* - Approximately 600,000 underground storage tanks are regulated by EPA's program. Underground storage tanks exist at more than 213, 000 sites located near population centers, putting indoor air and drinking water resources at potential risk. Leaks are common and, despite cleanup of more than 436,000 releases, there is a backlog of some 78,000 releases awaiting cleanup[8]. Fuel composition in the U.S. can change rapidly with mandates for biofuel use and industry response with new fuel components which have potential impacts on tank integrity and contaminant plume behavior and extent. Plumes of volatile organic compounds (VOCs) migrate with ground water and can contaminate municipal supply wells, private drinking water wells, or migrate into human-occupied buildings via transmission through underlying soil. Tanks research is focused on understanding, modeling, and remediating contaminant plumes resulting from leaks from underground storage tanks, and their impacts on buildings and water supplies, both private and public. This focus area aims to:

[8] Semiannual Report of UST Performance Measures, End of Fiscal Year 2013 (October 1, 2012-September 30, 2013). UST Program Facts, December 2013, Accessed at www.epa.gov/oust.

- Develop an improved conceptual model for petroleum hydrocarbon plume formation and migration from lab, field and modeling studies, which accounts for the spatial and temporal features that control plume migration.
- Develop a better understanding of fuel behavior at the water table and impacts to water supply wells from water table fluctuation caused by cycles of drought/extreme precipitation due to climate change.
- Develop the capacity to identify areas with high density of private wells, potentially leaking tanks, redevelopment sites and their proximities to water supplies.

LUST Emerging Issue: The impact of inadequate site characterization is being recognized as contributing to backlogged LUST sites and increased costs. Improved site characterization methods, such as Laser-induced fluorescence and membrane interface probe technologies, are providing a new capability to characterize the location of leaked fuels. The ability to bring these types of data into model-based assessment for decision-making is addressed in the LUST focus area of this project.

The key products for the LUST focus area include:

- Documented approach on private well-mapping research that describe protocols for determining well densities, proximity-driven risks to water supply wells, and redevelopment corridor locations.
- User's Guide for PVIScreen Model including distributable software.
- Report on ethanol corrosion studies and on-going tech support to states
- Report on gasoline composition, including expanded information for state agency use.
- Report on modeling hydrocarbon transport from sources located in various positions relative to the water table in support of backlog reduction, including supporting documentation for assessing subsurface impacts of fuel hydrocarbons, given variation in spatial and temporal features controlling transport.
- Report on density of domestic water well locations and proximity to LUST and potential brownfields sites, through the use of GIS tools.

**Nature of the Work**

The innovative research proposed in this project includes expertise in geo-spatial modeling, petroleum chemistry, biodegradation, optical sensing, hydrosol physics, regulatory acts, wave tank simulations, numerical model development, field and lab study expertise, and on-site and off-site contract management. The nature of the work includes:

- Identifying information gaps pertaining to oil spills and LUST;

- Developing improved oil spill surveillance tools and/or methodologies;
- Developing new protocols for the National Contingency Plan Product Schedule;
- Integrating lines of evidence collected during spills for improved decision-making activities;
- Developing spatial and temporal information on risks to surface and ground water receptors;
- Creating new conceptual and integrated models for transport of fuels and assessing impacts of contaminants under conditions of characterization uncertainty;
- Developing methods to incorporate models into GIS mapping tools to assess public health and ecosystems;
- Evaluating effectiveness of remediation to recovery to revitalization;
- Evaluating best available oil spill science to determine their utility in strengthening SHC research.

**Collaboration**

Work conducted through this charter is supported through collaboration with the following: Federal Agencies: National Oceanic and Atmospheric Administration, U.S. Coast Guard, Department of Interior's Bureau of Safety and Environmental Enforcement and U.S. Geological Survey.

EPA (outside of ORD): Office of Solid Waste and Emergency Response / Office of Emergency Management and Office of Underground Storage Tanks; *Office of Enforcement and Compliance Assurance; Office of Water and Regions 1-10.*

State or Other Organizations: State Underground Storage Tank Regulatory Agencies, Association of State and Territorial Solid Waste Management Officials, Interstate Technology Regulatory Commission and Tribes, Department of Fisheries and Oceans Canada.

Planned and/or anticipated collaborations within ORD (contribution to and from): SHC 1.61 (Structured Decision Making with inclusion of SDM in contaminated site management); SHC 1.62 (EnviroAtlas, incorporation of relevant GIS-based information on ecosystems into geo-spatial modeling for risk assessment); 2.61 (Community-based EGS, incorporation of EGS function and valuation in managing contaminated sites); SHC 2.62 & 2.63 (Community public health and vulnerable populations, addressing cumulative exposures to communities within and across regulatory programs, and GIS-based approach to addressing potential public health exposures); SHC 3.61 (Contaminated Sites, addressing cross-programmatic clean-ups); 3.63 (SMM, addressing cross-programmatic clean-ups); SHC 4.61 & 4.62 (Sustainability assessment and applications, evaluating the use of TRIO, Total Resources Impact & Outcomes, for environmental release of oils). Additional collaboration will be sought from the CSS, SSWR and ACE Programs regarding ecotoxicity of dispersed oil to organisms and air emissions from in situ burning.

Key resources cover a research program dedicated to developing methods and models improving spill and leaking tanks management. ORD will work with external entities conducting oil spill and tank research to leverage resources where possible. Funding through interagency agreements will also be pursued for added value to the program. Equipment and facilities needed include:

> *Oil Spill Focus Area*- gas chromatography-mass spectroscopy, high-resolution excitation-emission matrix spectrofluorometry, UV VIS absorption spectroscopy, in situ fluorescence and particle size analyzers, particle electro-sprays, streams facility and access to wave tank facilities. Expertise: biodegradation, optical sensing, hydrosol physics, and wave tank simulation expertise.
>
> *LUST Focus Area* - 2D physical model, gas chromatography-mass spectroscopy, fuel and diesel analyzers, drill rig, geoprobe and associated equipment. Expertise: numerical model development expertise, field and lab study expertise.

**Assumptions/Constraints**

One constraint is oil procurement, which has become increasingly difficult in recent years, resulting in reduced access to oils for testing.

**Project Charter Team Members**

Robyn Conmy, NRMRL (Project Lead)
Jim Weaver, NRMRL (Deputy)
Thabet Tolaymat, MI Representative
Fran Kremer, NRMRL
Randy Parker, NRMRL
Ronald Herrmann, NRMRL
Anthony Zimmer, NRMRL
Paul Randall, NRMRL

## 3.63 Sustainable Materials Management

**Project Number and Title**
3.63 - Sustainable Materials Management

**Project Lead and Deputy**
Thabet Tolaymat (interim NRMRL SHC MI / (Ed Barth – interim PL)

**Project Period**
FY16-FY19

**Project Summary**
This project will enable communities and the Agency to better protect and enhance human health, well-being and the environment for current and future generations, through the reduction in material consumption, reuse, and recycling of the materials to minimize the environmental impacts associated with products and materials. The projected integrated approach addresses the management of materials throughout their life-cycle in a cost-effective manner while minimizing negative environmental and socioeconomic impacts and incorporating community values. This Project consists of three major tasks that will result in the development of several products involving materials management resource tools to further advance the notion of integrative, sustainable materials management in cooperation with the Office of Solid Waste and Emergency Response (OSWER). This project addresses 3 of the 5 Agency Goals: Goal 1 - addressing climate change and improving air quality; Goal 2 - protecting America's waters; Goal 3 - cleaning up communities and advancing sustainable development. This project addresses climate change aspects resulting from material flow, management, and handling by evaluating alternatives from both an energy and greenhouse gas emissions perspective. Furthermore, this project addresses the following cross-cutting Agency strategies: (1) Working Toward a Sustainable Future,(2) Working to Make a Visible Difference in Communities,(3) Launching a New Era of State, Tribal, Local and International Partnerships, and (4) Embracing EPA as a High-Performing Organization.

**Project Description**

Problem and Decision Context

To reduce the threat of and impact of materials to public health and the environment, a sustainable approach for materials management will encourage the minimization and extraction of raw materials, reducing pressure on the use of non-renewable materials, recycling materials for beneficial reuse, substituting more benign materials into commerce, and maximizing quality of life and prosperity, or in closed-loop manufacturing. The framework for Life Cycle Management of Materials (LCMM) developed in this project will catalyze a shift from end-of-life thinking (*waste* management) towards a more integrated life-cycle approach (*materials* management) by developing and demonstrating life cycle assessment paradigms and material, product, and process design strategies that lead to reduced environmental impacts while preserving natural capital.

This project addresses 3 of the 5 Agency Goals: Goal 1 - addressing climate change and improving air quality; Goal 2 - protecting America's waters; Goal 3 - cleaning up communities and advancing sustainable development. This project addresses climate change aspects resulting from material flow, management, and handling by evaluating alternatives from both an energy and greenhouse gas emissions perspective. Furthermore, this project addresses the following cross-cutting Agency strategies: (1) Working Toward a Sustainable Future,(2) Working to Make a Visible Difference in Communities,(3) Launching a New Era of State, Tribal, Local and International Partnerships, and (4) Embracing EPA as a High-Performing Organization.

Outputs

This project will directly contribute to three SHC Outputs:

3.63.1 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 (FY17)

3.63.2 Strategy for sustainable materials management (FY18)

3.63.3 Tools for evaluating temporal and spatial impacts of materials management on public health and the environment, for use in restoration and revitalization decision making (FY18)

Focus Areas

Three focus areas will support the key outputs of the project and address the stated needs of client program offices by conducting systems oriented research and delivering products:

- Life Cycle Management of Materials (LCMM)
- Reuse of Organics and Other Materials
- Regulatory Support

Figure 1 shows the overall linkages between the three research focus area to the OSWER Priority Areas and key products that will be produced and available.

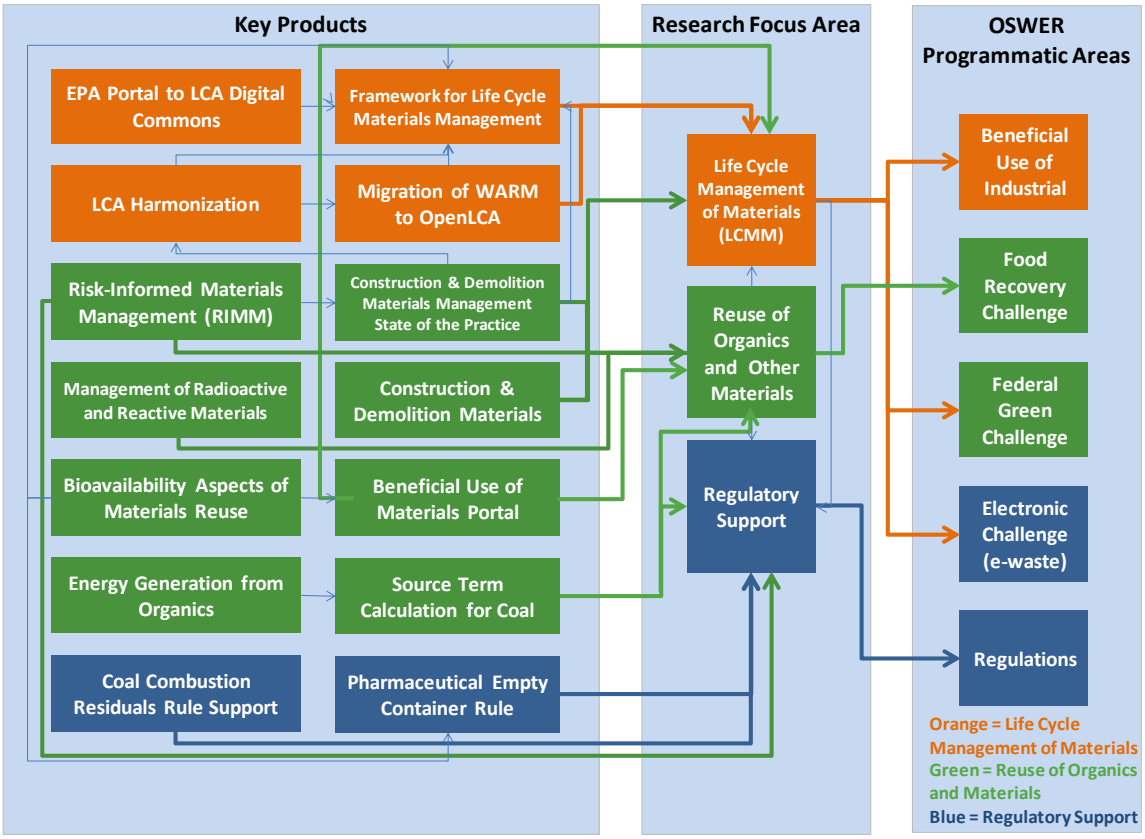

Figure 1. Project linkages between products and known research priorities

*Focus Area #1: Life Cycle Management of Materials* - As States and communities move towards sustainability, they must consider how to identify and reduce potential sources of environmental impact within their realm of influence, such as waste and water infrastructure, transportation systems, and industrial commerce. These decisions are made with the understanding that effective and sustainable environmental protection is linked to human health and quality-of-life, economic opportunity, and community vitality. In its 2009 report "Sustainable Materials Management: The Road Ahead[9]", EPA outlines its approach for sustainable materials management (SMM) as fulfilling human needs and prospering while using less materials, reducing toxics and recovering more of the materials used.

Life cycle assessment (LCA), as defined by the ISO 14000 series, has emerged as an invaluable tool for identifying the impacts associated with the environmental emissions and mass/energy flows of products and services. While life cycle thinking is a key part of SMM, careful consideration of how best to apply a product-centric tool like LCA to answer material-centric questions is needed to maximize the effectiveness of this approach. These considerations include not only the effects of the numerous methodological choices for LCA, but understanding the various types of decision that can be involved with SMM and the information needed to support these decisions. Such decisions might include top-down

management of materials based on policy or bottom-up approaches promoting sustainable material use through the development of viable material and process alternatives.

The LCMM focus area will develop a framework to support decision making within the nexus of LCA and SMM by integrating LCA methods being developed throughout ORD's national research programs (Air, Climate and Energy (ACE), Chemical Safety and Sustainability (CSS), Sustainable and Healthy Communities (SHC), Safe and Sustainable Water Resources (SSWR) and Homeland Security Research (HSR)) with approaches for the design of sustainable alternatives. Other methodologies for community material management will also be explored including urban metabolism. The intended outcome of the framework will be the identification of an optimum SMM strategy given the numerous options for impact reduction within a material life cycle. The initially proposed Framework for Life Cycle Materials Management (LCMM) envisions a 5-step process, including material prioritization, baseline assessment, alternatives development, alternatives assessment, and decision support that will enable users to identify materials of concerns and mitigate/eliminate associated impacts. The LCMM framework will provide process or product-oriented knowledge and will be complementary to community-level decision tools being developed within SHC.

In order to evaluate life cycle impacts, life cycle inventory (LCI) data that describe the manufacture, use, end-of-life management of high impact industrial and consumer materials is needed. LCI development within the context of this project will concentrate on end-of-life materials management processes (landfilling, recycling, etc.) because there are currently large data gaps for this life cycle stage for most materials. This work will also include development of a methodology to characterize the composition and volume of leachate from landfill processes. EPA has a unique capacity to provide these data and is already a leader as a data provider in the area of GHG emissions and characterization of MSW management through the WARM tool. Although the traditional use of landfilling for end-of-life is not the most desirable form of materials management in SMM, research on it is included in this project to provide more accurate models and data when establishing baseline scenarios in the framework. The data developed in this project should support not only in the tools developed by the Agency, but also the tools developed by other organizations. Therefore this project will include the design and implementation of an EPA portal to the Federal LCA data commons in collaboration with USDA, who has already launched a similar portal, and other federal agencies. The development of an EPA portal to the Federal LCA data commons is one of OSWER's top priorities.

Collaboration with state and local decision makers via stakeholder relationships established by OSWER and one or more Regional Offices will provide LCMM tools that can assist state and local governments in making effective materials management decisions. This will include adapting the current national level material prioritization tool (OSWER's SMM IO Tool) for state (and possibly community) level analysis and migrating this tool, as well as the EPA Waste Reduction Model (WARM), to an open platform that can incorporate all of the LCI or materials information being generated in SHC Project 3.63. Non-expert user interfaces will be implemented in LCMM tools to help decision makers easily obtain results that answer their specific questions regarding materials of concern. During the process of tool development,

stakeholder groups will provide feedback on the tools so that they are made more meaningful and useful to the various types of decision support in SMM.

Considering how national, state and local government policy makers might influence materials cycles, additional information is needed for tracking flows of high impact or high volume materials to aid in prioritization of SMM strategies. In particular construction and demolition debris (C&DD) is poorly characterized and tracked. Research in this focus area will include assistance for ORCR in developing a methodology to track C&DD at the national level. This research will support development of inventories for materials currently available in our nation's infrastructure, including old landfills and abandoned buildings. These inventories will assist stakeholders in devising local and national strategies to increase recycling and the potential "mining" of materials from landfills and brownfields.

The ultimate impact of the LCMM focus area will be the ability to assist stakeholders in decision making and implementation of effective and affordable materials management strategies at the product level to advance community sustainability, fostering improved public health, economic stewardship of resources and minimization of climate change impacts. As communities assess the future direction for SMM, they must also continue to evaluate the ramifications of legacy decisions. To that end the project will aim at addressing the issue of post closure care requirements for both subtitle C and D landfills.

The key products for the Lifecycle Management of Materials focus area are:

- National Generation Estimate of Construction and Demolition Debris following a bottom-up methodology
- Side By Side Evaluation of Life Cycle Tools for Waste Management
- Framework for Life Cycle Materials Management
- Life Cycle Inventory Databases of Materials Management
- Demonstrations of Life Cycle Materials Management
- Adaptation of Waste Reduction Model (WARM) to Open LCA
- Materials Management of Low Level Radiological Waste
- Life Cycle Materials Management Tools for Government and Industry Stakeholders.

*Focus Area #2: Reuse of Organics and Other Materials* - Beneficially using spent materials and waste streams as a feedstock, including those associated with organics for energy recovery options, provides an opportunity to reduce their life cycle impacts and improve the sustainability of the overall process.. Reuse of materials (e.g. industrial, agricultural and organic and inorganic sources) may contribute to benefits including offsetting the use of virgin materials in products or processes and potentially lead to reducing their adverse effects on the environment and human/ecosystem health. To address the key objectives of the SHC research program, this focus area will develop dynamic methods, data, strategies and tools to assist communities in framing sustainability goals to enhance energy generation and materials recovery from existing waste streams or underutilized material flows.

Thus, there is a need to optimize materials reuse and recycling while minimizing their environmental impacts and facilitating effective economic and social outcomes. Strategies to develop opportunities for materials reuse and valorization are based on our extensive knowledge of chemistry and engineering in designing more sustainable alternatives. It is the goal of this approach to demonstrate the opportunities that exist for producing useful and needed products from waste or spent material streams as well as ensuring these approaches have a minimal impact on the environment. It is also important to evaluate the utilization of biomass and food waste, especially the most abundant, natural and biodegradable biopolymers such as cellulose (from wood waste and agricultural residues) and chitin (from shrimp shells, crab and sea foods) for the synthesis of various mesoporous carbon materials. The biochar and magnetic versions of such carbonaceous materials could be used to make high-value products and in sustainable removal of contaminants from the environment. To extend on this focus area, another objective is to improve the effectiveness and efficiency of methods and guidance to address land and groundwater contamination sources (e.g. land application of specific outputs of anaerobic decomposition processes including digestate) and to encourage the use of innovative approaches to reduce new sources of contamination.

To assist society in fully utilizing these industrial and organic materials, this focus area involves the development and evaluation of technologies. In the case of organic materials, this research will provide reports and tools to make better use of currently available infrastructure at Waste Water Treatment Plants (WWTP) for organic materials management. A portion of this effort is to update a Region 9 tool (Co-EAT) and migrate it into open LCA platform to allow it better integration with other materials management models and approaches. This opportunity aims at tapping the currently unused capacity in the WWTP anaerobic digesters for processing non-wastewater organic material (pre- or post-consumer food waste). Furthermore, the focus area would assess innovation at local wastewater treatment plants related to beneficially using (and extracting energy from) organics, quantify the economic and environmental benefits of these practices, and determining the roadblocks to acceptance at non-innovating plants. There is a need for evaluation of methods to prepare collected gas for community use as well as targeting organic materials not traditionally evaluated for energy recovery. Part of this research may intersect with some biosolids work in SSWR.

Another example will include risk informed materials management models (RIMM) supporting the LCMM framework. The RIMM collection of interoperable models, databases and will form the overall base RIMM system including the establishment of the base HE2RMES v1.0 modeling domain in FRAMES v2.0, establishing a fully implemented D4EM-4-HE2RMES solution (as SDPProjectBuilder v1.0), servicing all of HE2RMES' science models, and improving and expanding upon the suite of natural science models in HE2RMES. The project is designed to be inclusive of OSWER technical staff who will provide ongoing consultation and design input on software development approaches, beta-testing efforts (as a future user), and demo uses of RIMM software technologies, and ultimately available to the public.

This focus area supports all three identified key outputs for this project by providing data, reports and tools for communities and regulatory officials to evaluate options for sustainable materials management at the national and local level.

The key products for the Reuse of Organics and Other Materials focus area are:

- Utilization of Organics and Biomass – Demonstration and Evaluation
- RIMM module HE2RMES demonstrations, OSWER in-house desktop operations, OSWER parallel computing/clustering capabilities, ORD-OSWER software/results exchange capabilities. Final RIMM module HE2RMES v1.0 with documentation
- RIMM Module D4EM Complete Application Assistance and Hand-Off to OSWER
- RIMM Module Landfill and Roadway Components
- Beneficial Use of Materials Portal (BUMP)
- Evaluation of Beneficial Use Impact on Climate Change

*Focus Area #3: Regulatory Support* - This focus area will provide technical support regarding questions concerning regulatory aspects of SMM. This focus area will also benefit from associated research in the project, but is somewhat different in scope than the other two focus areas. For example, ORD's ongoing support for coal combustion residues (CCRs) and answering technical questions with regards to the use of the leaching environmental assessment framework (LEAF) is focused here as well as the evaluation of the empty container rule for pharmaceuticals.

E-waste is another high impact research for OSWER and an EPA commitment under the National Strategy for Electronics Stewardship. Although a variety of data sources are available to quantify used electronic waste, there is a lack of coherent sets of information on used electronics and their domestic movement. To address this need a multiyear research approach is being developed, building upon the inadequacies of existing systems. The outcome of the research would identify methods for domestic tracking of quantity of used electronics and their flows. Develop, publish, and implement tracking methods that containing electronics quantities and flows. Depending on the method developed, ultimately ORD would implement it online for communities use.

In the short term, ORD would conduct a detailed characterization of the sources and quantities of used electronics flows that would assist decision makers especially at the EPA. Furthermore, states have their own used electronics management and recycling programs that provide more complexity to any effort aimed at quantifying E-waste generated. ORD's research would identify and quantify the potential effects of the state-level electronics recycling requirements. The evaluation should also address the inherent benefits and drawbacks for the states requirements. The evaluation should also address the economic effects of e-waste regulations and the impact of enacting similar regulations at the national level.

Depending on the type and quality of data currently available for electronic waste tracking (gap analysis), ORD researchers may be able to evaluate and summarize both top down and bottom

up methods, using mass flow or process models, for quantifying and tracking used electronics. Based on those results, ORD would develop a method for the estimates of used electronic waste generation, recycling and disposal within the U.S.

The key products for the Regulatory Support focus area are:

- Coal Combustion Residues Rule Regulatory Support
- Source Term Calculations for Coal Combustion Residues
- Electronic waste inventory and tracking system

**Nature of the Work**

Approximately 70% of the funds will be placed into extra-mural funding vehicles for specific task activities and managed by ORD technical staff. The remaining 30% being used for in-house research activities.

**Collaboration**

Program office partners: OSWER (ORCR), OCSPP, OAR, OW (OGWDW), OP, OSC

Regions: Region 4 for developing an SMM approach applicable at the state level , Region 3 development of secondary applications for spent industrial solvents FY14 RARE Project), Region 5 application of EPA pollution prevention and sustainability software. Region 9 development of SMM approaches for communities.

State(s): The State of Georgia for conducting a pilot study of a state SMM tool

Other federal agencies: USDA ARS for developing and publishing materials life cycle data consistent with the federal LCA data commons

Other SHC projects:
SHC 1.61 – Guidance for model development and interoperability will inform development of stakeholder SMM tools
SHC 1.62 – Incorporate Enviro Atlas as possible into the SMM support tools regarding location-specific impacts to ecosystem services related to material production or disposal
SHC 2.62– Utilize C-FERST in SMM support tools to identify location-specific health concerns that may be effected by changes to material cycles
SHC 2.63: Assessing Environmental Health Disparities in Vulnerable Groups
SHC 2.64 Indicators, Indices and the Report on the Environment
SHC 3.61 – Will provide this project ground water modeling for the LCMM support
SHC 4.6.1 – Demonstrate how life cycle approaches can be used to supplement TRIO assessments

SHC 4.6.2 – Will provide this project examples of tools that use systems approaches and consider multiple sectors to address community decisions.

Other ORD research collaborations:
ACE Sustainable Energy Evaluation (SEE) 1 – Regionalized air impact models based on spatially-resolved emissions, community-ACE SEE 1 – Community focused energy models and underlying electricity life cycle inventory data;
CSS 11.01 Lifecycle and Human Exposure Modeling (LC-HEM)–LCA data structure and software platform, models incorporating human exposure into the life cycle approach, rapid LCI modeling methods, Use of SHC-developed LCI data in CSS LC-HEM project.
CSS 9.01 Sustainable Chemistry – application of developed strategies/guidance for sustainable molecular design which could potentially be used for designing products that are readily biodegradable, possess physical or chemical properties that allow the molecule to be "taken apart" when an action is place on it and the resulting "two pieces" can be used for secondary application and for use in identifying opportunities for design of alternative products or processes.
ACE - climate change and impacts on materials management operations, historical operations as well locations TBD
SSWR – location of MM operations and impacts on water supplies/water quality

**Assumptions/Constraints**

An additional Life Cycle Assessment / Life Cycle Inventory (LCA/LCI) methodologist position has been advertised to supplement the existing team research team structure.

**Project Charter Team Members**

NRMRL
Ozge Kaplan
Susan Thorneloe
Richard Snow
Jennifer Goetz
Mark Kemper
Todd Luxton
Souhail Al-Abed
Derrick Allen
Ed Barth
David Carson
Chunming Su
David Meyer
Endalkachew Sahle-Demessie
Jane Bare
Leland Vane
Michael Gonzalez
Rajender Varma
Wesley Ingwersen

Kirk Scheckel
Steven Rock
Thabet Tolaymat

NERL
Justin Babendreier

Fran Kremer, NPD Representative
Thabet Tolaymat, MI Representative

## 4.61 Integrated Solutions for Sustainable Communities

**Project Number & Title**

4.61 - Integrated Solutions for Sustainable Communities

**Project Lead and Deputy**

Project Lead: Tim Gleason, US EPA, ORD, NHEERL AED
Deputy Project Lead: Jana Compton, US EPA, ORD, NHEERL WED FEB

**Project Period**

FY16-19 (October 1, 2015 – September 30, 2019)

**Project Summary**

ORD, EPA, and the National Academy of Sciences have recognized that setting goals of sustainable environment, sustainable society, and sustainable economy, and providing communities with the capacity to incrementally reach those goals, will significantly increase our ability to meet the challenges of the future. Since its inception, the SHC research program has focused research on understanding components of sustainability and decision-making and here seeks to bring this research together and provide guidance for communities that is sensitive to individual context, specific issues of interest, existing community capacities, and the drivers and system dynamics that challenge communities. This project seeks to support sustainable communities by conducting research that will: 1) provide clear guidance to decision-makers on selection of tools and best practices 2) improve, extend and functionally 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 in resolving complex issues to promote sustainability. The project is divided into three focus areas. Focus Area 1 - Sustainability Toolbox (CSAS) is developing approaches to deliver sustainability tools through the Community Sustainability Analysis System (CSAS). This focus area will work closely with the Office of Policy and the Regions to deliver tools to communities and will also provide a conduit for feedback to inform the development of future tools. Focus Area 2 - Sustainability Assessment & Management (SAM) Process for Communities; will develop integrated approaches that provide tools and information that a community can use to: assess decision alternatives in a holistic or systems context (economic, social, and environmental), evaluate the implications and tradeoffs across the components (sectors) of the system, and move towards more sustainable solutions. The research considers direct and indirect outcomes of decisions related to the sectors of land use, the natural and built environment, transportation, waste management, water, and the larger-scale sectors of air, water, climate, energy, and security. Focus Area 3 - Case Studies is targeting applications of systems approaches for sustainability through demonstration projects. The research will focus on applications to real-world problems where systems approaches are being or can be used, in order to evaluate the effectiveness of sustainability-oriented decision-making and management practices that integrate social, environmental and economic concerns. The demonstrations will utilize, test, and evaluate existing sustainability tools where appropriate and increase our understanding of key relationships that can inform sustainability assessments.

**Project Description**

Problem and Decision Context

Working towards a sustainable future is one of four cross-EPA strategies. Moving towards a sustainable future will require both regulatory and non-regulatory practices, tools and example approaches that will allow communities to weigh and ideally optimize among potential outcomes, and take actions to reduce our impact on land, air and water through use of materials, water and energy in a more sustainable manner, thus achieving improved human health and well-being in a manner that is equitable and proactive. Communities face a variety of challenges moving towards sustainability. For example:

- Many decisions communities routinely face seem simple, but actually have complex implications and unanticipated outcomes.
- Decision-makers at all scales face increasingly complex issues that require new approaches for decisions they routinely make.
- Communities have differing capacity to address complex problems such as sustainability

This project will attempt to assist communities' efforts to move towards sustainability by developing, testing, and delivering a range of simple to complex tools to support decision making. Holistic approaches that consider all 3 dimensions of sustainability have the potential to identify cascading impacts and opportunities to leverage resources, however methods to clearly identify and communicate the net benefits of actions need work. For complex decisions (suites of interrelated problems) where solving an individual problem often causes or exacerbates another, we propose to develop and test integrated solutions (holistic or systems approach) that capture net benefits through a sustainability assessment process can move a community towards an optimized set of outcomes. These approaches will draw from the available tools inventory (from SHC 1.61) as well as require the development of specific tools and practices that present an overall process for sustainability assessment and management at multiple decision-making levels. The ultimate goal is to develop a unifying approach that integrates social, economic and environmental considerations and measures for decision-making.

Decisions facing communities often involve multiple stakeholders, interventions, and outcomes that exist across multiple spatial and temporal scales (local, regional and national). In this project, we will work to develop, apply and test the systems-based tools produced within SHC, across other EPA programs and other available tools that elucidate the tradeoffs inherent to decisions facing communities. Methods and approaches that incorporate the economic, environmental, and social dimensions of communities will be developed, applied and tested to determine whether these applications result in decisions that better support community sustainability. Connected research and approaches from all other research program areas will

also be brought into this project research where appropriate. We realize this is an ambitious goal because in many cases there are data limitations and research gaps, lack of causal relationships between human actions and the three dimensions of sustainability (such as adequate stressor-response relationships for a broad range of ecosystem services), or gaps in perspective that prevent us from reaching this goal today. A key component of this work is developing a process to assist communities in framing their decisions and to connect decision-makers to specific tools and information needed for their particular decisions. This would mean that we need ways to stratify and organize tools and information by types of decisions, size of community, etc. Thus, for many decisions and many systems, there is a need to further develop the causal relationships between human actions and the three dimensions of sustainability and to continue to improve our understanding of key causal relationships. We may not currently have all the tools and indicators we need to carry out this work, for each sector, stressor or system, but this project will assemble and apply the current tools to address questions facing communities. Another key component is addressing where gaps exist in knowledge and understanding, especially where addressing those gaps has the potential to significantly benefit to communities making difficult and complex decisions. This research effort will attempt to preliminarily evaluate whether holistic systems-level approaches in real-world applications result in improved efficiencies, a reduction in unintended consequences, and desired improvements in social, economic and environmental dimensions of communities at local, regional and national scales, but recognizes that these responses may take many years to become evident.

Outputs

Output 4.61.1: Implications of Decisions in Land Use, Transportation, Buildings, Infrastructure, Waste, and Materials Management on Community-Level Sustainability. (FY15)
Output 4.61.2: Prototype of a web-based information portal (CSAS) to provide access to tools and information related to community sustainability (FY15)
Output 4.61.3 Sector-based guidance and improved decision tools (including sustainability assessment) for pursuing community sustainability through holistically-informed (i.e. using a systems approach) community decisions in land use, transportation, buildings and infrastructure, and waste and materials management. (FY18)
Output 4.61.4 Tools to inform regulatory and non-regulatory solutions to nitrogen pollution through the consideration of impacts/effects on ecosystem services. (FY18)
Output 4.61.5 Refine the Community Sustainability Analysis System (CSAS), web-based information portal, based on partner and community feedback and interests. (FY19)
Output 4.61.6 Interim and updated Guidance for Sustainability assessment approaches, for use to proactively inform community decisions and advance sustainability. (FY19)
Output 4.61.7 Achieving community sustainability: synthesis of findings from case studies. (FY19)

Focus Areas

This project is divided into three focus areas. Focus Area 1 Sustainability Toolbox (CSAS) is

developing approaches to deliver sustainability tools where appropriate through the Community Sustainability Analysis System (CSAS). Focus area 2 Sustainability Assessment & Management (SAM) Process for Communities. This focus area builds from earlier sector-based analyses and is designed to provide communities with approaches to weigh the consequences of various decisions including those related to land use change, the built environment, green infrastructure, ecosystem services, water resources, and public health. Focus Area 3 consists of case studies intended to apply and test systems approaches for sustainability through demonstration projects. Each demonstration project utilizes a systems framework. The demonstrations utilize, test, and evaluate existing sustainability tools where appropriate and increase our understanding of key relationships that can inform the development and application of future sustainability assessments.

*Focus Area #1: Sustainability Toolbox (CSAS)* - This focus area is delivering tools and resources needed to inform sustainability approaches through a web-based portal, the Community Sustainability Analysis System (CSAS). Access to the tools and resources necessary to implement these approaches will be the focus of work in this area. As part of the Cross-Agency Communities Strategy, the Office of Research and Development (ORD) is partnering with Office of Policy (OP) and Region 1 to enhance EPA's communities' microsite (user-friendly, one-stop resource to serve local government officials and community members). ORD is developing a question-based interactive tool (commonly referred to as a wizard, or "turbo-tax" tool), leveraging existing tools and efforts to identify the most pertinent information and tools based on background and needs provided by the end user. This effort will initially focus on (a) supporting community decisions related to green infrastructure (GI)/stormwater management/integrated planning; and (b) supporting community decisions focused on materials management.

The wizards would take the form of web-based question trees that guide local decision makers to our decision tools by asking pertinent questions about decision context such as: What size of community do you represent? What geographical area do you represent? What are the most compelling issues (in the 2 initial focus areas) are you seeking to address? With each subsequent question, the wizard/question tree would guide end users to appropriate information resources and decision support tools/modules. SHC is calling this "CSAS" – Community Sustainability Analysis System, which would initially be a portal including these 2 separate wizards. The CSAS will be a pilot approach to providing user-friendly access to multiple relevant information sources and tools to facilitate community decision-making. An important goal will be balancing front-end usability for EPA community stakeholders with the range of tools to address their needs. For the initial effort, existing tools in ORD/Office of Water (OW)/Office of Solid Waste and Emergency Response (OSWER)/Regions will be considered (e.g., Green Infrastructure Tools and Resources (GITAR), Stormwater Calculator, Municipal Solid Waste Decision Support Tool (MSW-DST), cross-Regional zero waste tool, Waste Reduction Model (WARM) as well as initial ORD/SHC efforts towards a searchable library of community-focused tools. CSAS will empower communities to find appropriate tools, from a select group of

existing tools, and information to support decisions toward achieving sustainability, including goals associated with green infrastructure and materials management. This focus area will contribute to outputs 4.61.2 and 4.61.5.

The key products for this focus area will be:

- Identify and convene a workgroup, including key EPA partners and external stakeholders – intended CSAS end users – to prioritize materials and stormwater management issues, collectively consider available relevant tools for leveraging, and conceptually design the prototype. The stakeholders will be identified as willing, enthusiastic collaborators throughout the design process and case study demonstrations.
- Initial prototype of web-based wizard(s) to facilitate tool access by community leaders with understanding water management issues, information, and tools.
- Test and refine Prototype of the materials and water management web-based wizards, in full collaboration with stakeholders who are critical members of the team, to support pilot community decisions.
- External peer review and public release of the green infrastructure and materials management wizards.

*Focus Area #2: Sustainability Assessment & Management (SAM) Process for Communities* - This research will develop integrated approaches to allow communities to holistically evaluate decisions across multiple sectors. The research considers direct and indirect outcomes of decisions related to the sectors of land use, the natural and built environment, transportation, waste management, water, and the larger-scale sectors of air, climate, energy, and security. Sector based synthesis papers (land use, buildings and infrastructure, materials management and waste, and transportation) delivered in 2014 will be the initial foundation for developing a systems approach to interpret the implications of decisions across those sectors through the lens of sustainability. Approaches will range from simple conceptual integration and synthesis to more complex systems dynamic models. We define Sustainability Assessment and Management (SAM) as an approach that provides tools and information that a community can use to assess decision alternatives in a systems context (economic, social, environmental), evaluate the implications and tradeoffs across the components (sectors) of the system, and move towards more sustainable solutions.

Other efforts across the SHC program will also inform the development of sustainability assessment approaches. This research will be closely coordinated with future efforts in the Office of Policy and initiatives in the Regions, as well as other SHC projects/products. For example, from other SHC Projects: 1.61: e.g., Guidance to support the design of software applications and decision processes for different types of communities (Initial version FY16); A searchable library of available decision support tools (FY-18); 2.61: e.g., Ecosystem goods and services production and benefit functions case studies report (FY16); Incremental report on the impacts of human actions and environmental forces (particularly climate change), on the production and supply of final ecosystem goods and services (FEGS) and the effects on human

health and wellbeing(FY17); 2.62: e.g., Demonstrations of Applying Tools, Methods, and Community Engagement to Mitigate Environmental Health Impacts In At-Risk Communities; and Synthesis of Best Practices Learned from Community Participatory Studies that Address Environmental Health Concerns within Communities; 2.63: e.g., Development of a systems level approach to understanding children's environmental exposures, health and environmental diseases, FY16; Translational research to incorporate data and information on children's environmental health (CEH) into tools to inform community actions, FY19; Research to inform Tribal sustainability, FY19.

Informed by products coming from the above outputs, feedback from partners and users of the CSAS and its content, and augmented as necessary by targeted literature reviews (including total cost accounting and trade off analyses), ORD will also seek to determine which approaches are most valuable and appropriate for the Regions and Program offices to use as they assist communities in meeting regulatory and voluntary compliance. This will include: evaluating where the approaches have been used and what was learned from those applications; trying to determine what the barriers to adoption of these approaches might be; determining what adaptive management strategies are effective in a systems and sustainability rubric, as well as, identifying the key future research needs. This focus area will contribute to outputs 4.61.1, 4.61.3, and 4.61.6.

The key products for this focus area will be:

- Synthesis of decision sector analyses.
- Sector-based guidance and improved decision tools for pursuing community sustainability through holistically-informed (i.e. using a systems approach) community decisions in land use, transportation, buildings and infrastructure, and waste and materials management.
- Interim and updated Guidance for Sustainability assessment approaches, for use to proactively inform community decisions and advance sustainability.
- A transferrable, scalable, transdisciplinary methodology to estimate net risk/benefits (i.e. sustainability assessment) using multi-sector approaches.
- Application of structured decision making approach (Decision Analysis for a Sustainable, Environment, Economy, and Society (DASEES)) to community decisions

*Focus Area #3: Case Studies* - This focus area is targeting applications of systems approaches for sustainability through demonstration projects. This research will focus on applications to real-world problems where systems approaches are being or can be used, in order to evaluate the effectiveness of sustainability-oriented decision-making and management practices that integrate social, environmental and economic concerns. The demonstrations will utilize, test, and evaluate existing sustainability tools where appropriate and increase our understanding of key relationships that can inform sustainability assessments. These case studies will be selected based on their potential to provide information needed by stakeholders and decision makers to make informed decisions and choices related to their communities, as well as

providing information and insights that would be scalable and transferable to other places. Some case studies are ongoing in SHC from FY12-15 Research Action Plans (RAPs), but we will also be identifying new case studies in FY15 to be part of this new RAP. The following initial criteria will be used to aid in the identification of demonstration case examples:

- Provides opportunity for coordination with other national programs (e.g., OW, OSWER, Office of Transportation and Air Quality (OTAQ) or Office of Air Quality Planning and Standards (OAQPS) programs) to focus on community needs or developing approaches to sustainability
- Provides an opportunity to look at impacts and outcomes across the 3 dimensions of sustainability using a systems approach
- Provides an opportunity to look across multiple decision sectors (for synergies, improved efficiencies, co-benefits etc.)
- Utilizes multiple SHC (and other) tools and approaches, thus allowing refinement and evaluation (a sustainability analysis approach might use a suite of tools from various sources)
- Builds on prior work from within SHC, within ORD, Program Offices, Regions and outside of the agency where approaches require assessment (e.g. NOAA and EPA-OTAQ work on ports, State and local integrative floodplain management, nitrogen management tools
- Addresses the interests of communities and other key partners (EPA Regions) outside of ORD
- Informs decision making in other locations (transferable) and broader geographic areas (scalable)
- Does not duplicate work being done in other parts of SHC and other programs.

Summary and analysis of the case study assessments will also help to inform future directions of the Program. Completion of this project will allow identification of applications where systems approaches to decision-making provide insight to complex indirect relationships, avoidance of unintended consequences, identification and estimation of co-benefits, and analysis of trade-offs, thus demonstrating how systems-based approaches can inform outcomes that support sustainability. This focus area will contribute to outputs 4.61.4 and 4.61.7.

a) *Integrated Nitrogen Management* - The excess release of nitrogen to the environment is a significant and pervasive cause of degradation of air and water quality across the nation that affects human health, as well as economic and environmental conditions. The implications of nitrogen pollution and nitrogen management will be holistically evaluated through application and testing of systems based tools. The research that addresses issues of concern related to nitrogen will build on the portfolio of nitrogen research inside and outside of the SHC Program and the Agency including research on ecosystem goods and services (SHC 2.61), SHC Project 1.62 EnviroAtlas, Air Climate and Energy (ACE) MDST-3, SSWR 2.3 and the Nitrogen and Co-Pollutant Road Map, to provide and/or apply relevant decision making approaches to address a range of environmental decision making. The basic goal is to provide stakeholders a way to determine which interventions to nitrogen sources and inputs will meet their goals,

including social, environmental and economic endpoints. The research will recognize that multiple source sectors (land-use, energy, transportation, infrastructure, materials management) at a variety of scales contribute to the nitrogen cascade and multiple sectors respond to the effects of nitrogen on human well-being and ecosystem services. The research also recognizes that nitrogen interacts with other co-pollutants and will provide a basis to more fully capture the positive benefits of nitrogen use while limiting the negative impacts on human health, well-being and ecosystems. This focal area uses data from across EPA program offices and research programs using a variety of models and inventory data sources, and also many other data and models generated by USDA, USGS and other organizations. Research outputs will include tools, model sets, maps, databases, case studies and what-if scenarios that support consideration of the total resource impacts on air, land and water media and outcomes through the systems framework suggested by the nitrogen cascade and consider associated co-pollutants, climate change, and socio-economic factors related to the tradeoffs inherent to environmental decision making at local, regional and national scales. Partners: OW-IO, OW-OST, OW-OWOW, OAR-OAQPS, OAR-OAP, Regions, Hypoxia Task Force, Chesapeake Bay Program, Numerous local partners in community target areas (coastal watersheds with N TMDLs in Connecticut and Rhode Island, Nitrate GWMAs in Washington and Oregon).

Some key products include:

- State of the science frameworks, tools, approaches and data to evaluate the implications of nitrogen pollution and nitrogen management options (regulatory and non-regulatory) holistically, within the context of changing climate, food production demands, and demography.
- Updated information on dose-response relationships, in particular effects of N on ecosystem services.
- Publically accessible data and information on historic, current, and future projected N sources, loading and trends by origin and/or sector available to decision makers and planners.
- Integrated total resource analyses accounting for the costs and benefits of nitrogen for a range of human health and ecosystem endpoints.
- Multi-endpoint scenarios of nitrogen futures, addressing tradeoffs and unintended consequences and incorporating interactions with climate change effects, to show communities what will be gained and lost under different management and policy actions.
- Cutting edge tools and approaches that can be used by local, regional, or national decision makers and planners to facilitate holistic, sustainable nitrogen management.
- Approaches, methods, and actions to manage nitrogen and build coastal resiliency to climate change are identified.

- Performance metrics (provision of specific ecosystem services - for example water quality maintenance and flood abatement) and targets of success are agreed upon at stakeholder meetings.
- Monitoring of nitrogen management and climate adaptation actions with appropriate tools.

b) *Sustainable Ports* - In real-world situations, communities make decisions that have their origins in one sector or another, but whose outcomes occur either as a cascade of impacts through multiple sectors or can be optimized by coordinating actions arising from different sectors. Such multi-sector interactions are especially important for emergent outcomes, such as community health, resilience, and sustainability. The tools that currently exist to support sector-specific decisions are seldom designed to take into account these interactions or the emergent outcomes, even as the impetus to do so increases. The purpose of the present demonstration project, then, is to consider how existing tools and those currently under development by SHC can, when used in combination and in concert, account for the interactions among sectors to translate sector-specific decision to emergent outcomes. This Ports demonstration presents an excellent opportunity to integrate aspects of existing and planned SHC products - such as C-FERST (Community Focused Exposure and Risk Screening Tool), C-PORT (Community-Port assessment model) and the EnviroAtlas – and can be used to analyze cumulative risk, exposed populations, and the extent to which ecosystems services, or their absence, affects mitigation of stressors and/or access to services that promote well-being in response to actions ranging from sector-specific (i.e. transportation systems) to more general (e.g. globalization, climate change). The principal interacting sectors include materials safety and contaminated sites (Waste, Energy, Homeland Security), buildings and infrastructure, and water resources. Each of the needed assessment tool products listed above already includes some port communities among their applications; this effort would look to increase their co-location as a basis for integration. HIA is an important tool for ports communities, and the availability of source emissions and air quality data and models will be a strong input to HIAs for the planned US port expansions anticipated as a result of the Panama Canal expansion. The consideration of multi-modal freight transportation (marine, truck, train), brownfields, contaminated sites, and other sectors of the built environment (e.g. housing, water infrastructure, etc.) will draw heavily on work in other SHC project areas as well.

   Also in SHC, two Regional Sustainable Environmental Science (RESES) grants have been awarded investigating sustainable port development and assessment. One grant will expand the use and applicability of the C-PORT model to a web resource capable of assessing multiple port locations. The other RESES grant will provide inland port communities with a review of models and tools that can be used to understand and improve their options for resiliency in the face of extreme weather events, anticipated to increase with climate change concerns. This effort will review existing tools and models for assessing alternative freight transport options from an environmental, social and economic perspective, and provide recommendations for future model

development and research needs. Research conducted in ACE on truck, rail, and marine emissions and impacts will also provide input to the systems-based tools developed or refined through SHC's ports focus area. This ports-related research will also aid partners within EPA (e.g. OTAQ, Regions) and external agencies (e.g. NOAA, Army Corps of Engineers (USACE)) in the development of best management practices for sustainable ports. Partners: OTAQ, Communities in the RESES project, regional offices, NOAA, USACE.

Some key products include:

- Approach that incorporates social, economic and environmental dimensions of sustainability for inland and seaports.
- Tools and resources for scenario planning and sustainable best practice identification for ports development and resiliency planning, using SHC and external resources (e.g. OTAQ, NOAA Port Resilience Tool, Geospatial Intermodal Freight Transportation (GIFT) model, C-PORT, EnviroAtlas, MARKAL (an acronym for MARKal ALlocation)).
- Expansion of C-PORT development for air quality impacts (current SHC task 4.1.3.2) from multi-modal freight transport.
- Development and evaluation of best practices to provide guides and resources for ports including the evaluation and expansion of resources developed under SHC, ACE, and SSWR research programs.
- Methods and tools to compare and improve multi-modal transportation system planning and options to promote sustainability and efficiency at the port and surrounding communities.

c) *Sustainable Community Water Management* - Water management issues (storm water, wastewater, water quality and water quantity) intersect with other sectors (transportation, land use, buildings and infrastructure, materials and waste management, energy, agriculture, public health) of concern for communities. Communities need to consider water management within a systems context that allows for connections between these sectors. For instance decisions about storm water have implications for land use, green and gray infrastructure, transportation, waste management, economics, public health, water quality and adaptation to climate change to name a few. This project would be an integrative effort explicitly linked with the watershed sustainability research effort in the Safe and Sustainable Water Research Program (SSWR). This research will use a systems approach (ranging from simple conceptual models to more complex systems dynamics models) to address all three dimensions of sustainability, considering aspects of the land-use, energy, waste, and materials sectors as they intersect with watersheds, water quality, water quantity, and communities. This research will also will consider explicitly the linkages between social science, human health and well-being and environmental outcomes. Systems approaches (e.g., VenSim/3VS, Hygeia, or DPSIR (a causal framework for describing the interactions between society and the environment)/structured decision making) will frame this research. Their application will draw from other portions of SHC (particularly

2.61), as well as from complementary efforts in SSWR, ACE, and the 3VS demonstrations occurring across the country. Emphasis will be given to partnering within EPA (e.g., with SSWR, OW, OSWER, Regions), with other governmental agencies, with private sector groups, and of course, with the community itself.

A number of potential locations are currently under consideration. The key selection criteria, in addition to those listed above, would include: active EPA partner engagement (PO and Region); community engagement; opportunity for cross ORD coordination; opportunity for ORD research to influence/inform decision making; transferability of research to other communities. Cape Cod, MA is one potential candidate for a demonstration in that this region faces acute challenges in sustainably managing its water resources, has established community groups who are engaged in seeking sustainable outcomes, has concerns about environmental equity (who pays, who benefits), has an interest in partnering in a demonstration, has a strong advocate in the form of EPA Region 1 and has multiple small watersheds that may represent quasi replicates for experimental evaluation and model testing at community and regional scales.. The Puget Sound's Snohomish Basin is another viable candidate for a demonstration, where sustainable watershed management solutions are needed to protect Puget Sound, and tribal fish and shellfish beds, in particular. In addition, climate change is of great concern in the area because it is predicted to have a great effect on the hydrology and fisheries of the region and associated commercial and recreational activities. Other communities, such as Phoenix, AZ, Lower Yakima River Basin, WA, and Austin, TX, might also be logical candidates. The efforts will coordinate with other demonstrations and Net Zero efforts to populate SHC's developing sustainability assessment approaches for water, waste, energy, and materials management strategies. Water infrastructure sustainability research would review and utilize outputs from ORD/STAR on health effect-water infrastructure links, ORD/NRMRL and OW water infrastructure research and decision support tools (e.g. www.epa.gov/awi and http://water.epa.gov/infrastructure/sustain/), ORD human health and ecological research, and tool testing and application will be critical for the sustainability conceptual framework. Modules and information from existing tools such as DASEES, C-FERST, EnviroAtlas, Stormwater Calculator, the Regional zero waste tool will be demonstrated as appropriate. Additionally this research will also coordinate closely with the Safe and Sustainable Water Research Program, SSWR 3.1 (green infrastructure (GI) tools and modeling approaches) and SSWR 3.2.1 Informing GI implementation through community pilots. This work addresses outputs 4.62.2 and 4.62.3. Partners: Relevant program offices, regions and local communities.

Some key products include:

- Summary of outcomes from the sustainable watershed focal areas, emphasizing how the 3 dimensions of sustainability were incorporated into community decisions and illustrating outcomes.
- Sustainability assessment of differing suites of interventions with opportunities to test model results.

- Improved systems approaches through improved understanding of key relationships.
- Guidance to communities for sustainable decisions that balance, social equity, land use, public health, waste management, transportation, energy use, water management, innovation and climate change adaptation.

**Nature of the Work**

This research will draw on intramural FTE and funding as well as extramural resources. Extramural resources will be used to support students and post-docs, and where necessary and appropriate, contracts, cooperative agreements and interagency agreements that lead us to the outputs. Community outreach and engagement will be a critical component of this work in the demonstration areas. The precise nature of the work will be more defined during the next phase of developing the project management plan. Additionally, the Regional Sustainable Environmental Science (RESES), a competitive program that promotes Regional and ORD collaboration and engagement on key sustainability science needs will be part of this project.

**Collaboration**

Our partners made it clear, during their review of the draft charters, that it is essential that they be engaged up front in the development of these projects to ensure that the results of this research could be applied to the problems being addressed by our partners. The subsequent project plans will need to engage key partners and collaborators. Specific collaborators will depend upon the focal area development. Also, there is the intention that this project serve in a synthesis role for SHC. So, there are a number of internal collaborators from SHC that would interact with and provide input to this project and the outputs (e.g. tools developed in decision support (1.61), data from the EnviroAtlas (1.62), the FEGS information (2.61), possible example case studies (2.61), health tools (2.62 and 2.63), indicators and indices of community sustainability (2.64), information about contaminated sites, waste and fuels (3.61, 3.62 and 3.63) and the approaches developed and integrated from the entire program (4.61).

For the case studies, stakeholders will include the community members of each of the case studies assessed; Regional partners; Program Office partners; other ORD research programs, SHC Program managers who can adjust future directions based on the findings of the assessment; and other sustainability researchers in government and academia. For example, Output 4.61.4 will draw on findings from a variety of sources (e.g. Air Climate and Energy (ACE), Human Health Risk Assessment (HHRA), SSWR nutrient research, OW, OAR, Regions, communities, local governments, POs, other federal and state agencies (e.g., USGS, USDA, state environment and health departments, watershed councils, soil and water conservation districts), NGOs, and academia). Specific stakeholders and collaborators will depend on the exact nature of the task (for example, the “Ports” component would target port communities) and are, in large part, addressed in the example task descriptions above. OTAQ is a primary a partner in the Ports work, and has a good handle on the relevant stakeholder group at a variety of decision scales. Generally speaking, the primary stakeholders are community leaders such as

state & local governments, watershed councils, soil and water conservation districts, USDA NRCS, utilities, city planners, developers. Other interested parties and potential cooperators include program and regional EPA offices, other federal agencies, NGOs, and academia.

7. Project Charter Team Members

| First Name | Last Name | Lab/Center |
|---|---|---|
| Tim | Gleason | NHEERL |
| Jana | Compton | NHEERL |
| Rochelle | Araujo | NERL |
| Ted | Angradi | NHEERL |
| Rich | Baldauf | ORD/NRMRL and OAR/OTAQ |
| Jake | Beaulieu | NRMRL |
| Doris | Betancourt | NRMRL |
| Dave | Bolgrien | NHEERL |
| Allen | Brookes | NHEERL |
| Jennifer | Cashdollar | NERL |
| Chris | Clark | NCEA |
| Ellen | Cooter | NERL AMD |
| Robin | Dennis | NERL-AMAD |
| Naomi | Detenbeck | NHEERL-AED |
| Brian | Dyson | NRMRL |
| Bill | Fisher | NHEERL/GED |
| Gary | Foley | NRMRL |
| Ken | Forshay | NRMRL-GWERD |
| Michael | Gonzales | NRMRL |
| Eric | Hall | NERL |
| Vlad | Isakov | NERL |
| Scott | Jacobs | NRMRL |
| Eric | Jorgensen | NRMRL |
| Ozge | Kaplan | NRMRL/APPCD/APB |
| Joe | McDonald | NRMRL |
| Andy | Miller | IOAA/ACE |
| Ardra | Morgan | NRMRL |
| Mike | Nye | NERL |
| Jim | Power | NHEERL/WED/PCDEB |
| Anne | Rea | IOAA |
| Mike | Royer | NRMRL/WSWRD |
| Kathryn | Saterson | NHEERL MI |
| Joseph | Schubauer-Berigan | NRMRL, LRPCD |

| | | |
|---|---|---|
| Marilyn | ten Brink | NHEERL-AED |
| Cathy | Wigand | ORD-NHEERL-AED |
| Tony | Zimmer | NRMRL |
| Melissa | McCullough | IOAA |
| Betsy | Smith | IOAA |
| Valerie | Zartarian | NERL ALD/MI for SHC |
| Mary | Reiley | OW OST |
| Ginger | Tennant | OAQPS HEID |
| Randy | Waite | OAQPS HEID |
| Thabet | Tolaymat | NRMRL MI |