UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
RESEARCH AND DEVELOPMENT

MAR 03 2020

Paul Gilman, Ph.D.
Lucinda Johnson, Ph.D.
Co-Chairs
Board of Scientific Counselors
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Dear Drs. Gilman and Johnson:

Please find accompanying links to the five (5) final Strategic Research Action Plans (StRAPs) for 2019-2022, and responses to recommendations regarding these StRAPs in your August 19, 2019 Board of Scientific Counselors (BOSC) Report[1]. The detailed responses to each of the recommendations are included in red text in the body of the BOSC Report. The StRAPs listed below are available at: https://www.epa.gov/research/strategic-research-action-plans-2019-2022.

- Air and Energy (A-E)
- Safe and Sustainable Water Resources (SSWR)
- Sustainable and Healthy Communities (SHC)
- Chemical Safety for Sustainability (CSS)
- Homeland Security Research Program (HSRP)

The ORD Response to BOSC Recommendations is available at: https://www.epa.gov/bosc/bosc-review-ords-2019-strategic-research-action-plans-and-ords-responses-bosc-recommendations.

ORD very much appreciates the work and input from the members of the BOSC. Your review has helped ensure that ORD's scientific research programs remain robust and focused on ultimately informing decisions made by EPA and others to protect public health and the environment. We will be working with the BOSC Chemical Safety for Sustainability Subcommittee over the Spring to review the sixth StRAP, Health and Environmental Risk Assessment (HERA; previously HHRA). We look forward to working with the BOSC under your leadership as we move into implementation of the research programs.

Sincerely,

Jennifer Orme-Zavaleta, Ph.D.
Principal Deputy Assistant Administrator for Science
and EPA Science Advisor

[1] https://www.epa.gov/bosc/bosc-review-ords-new-strategic-research-action-plans-2019

BOSC

BOARD OF SCIENTIFIC COUNSELORS

# REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

## BOSC EXECUTIVE COMMITTEE


Paul Gilman, Ph.D. (Chair)
*Covanta*

Lucinda Johnson, Ph.D. (Vice Chair)
*University of Minnesota Duluth's Natural Resources Research Institute*

Viney Aneja, Ph.D.
*North Carolina State University*

Robert Blanz, Ph.D., PE
*Arkansas Department of Environmental Quality*

Lance Brooks
*Defense Threat Reduction Agency*

Shahid Chaudhry, MSc
*California Energy Commission*

Kari Cutting, MS
*North Dakota Petroleum Council*

Courtney Flint, Ph.D.
*Utah State University*

Charlette Geffen, Ph.D.
*Pacific Northwest National Laboratory*

Matthew Naud, MPP, MS
*adapt.city LLC*

Paula Olsiewski, Ph.D.
*Alfred P. Sloan Foundation*

Joseph Rodricks, Ph.D.
*Ramboll Environ*

Leslie Rubin, M.D.
*Morehouse School of Medicine*

Sandra Smith, MS
*Retired*

James Stevens, Ph.D.
*Paradox Found LLC*

Katrina Waters, Ph.D.
*Pacific Northwest National Laboratory*


EPA Contact
**Tom Tracy, Designated Federal Officer**

August 19, 2019

*A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development*

Disclaimer Text. This report was written by the Executive Committee of the Board of Scientific Counselors, a public advisory committee chartered under the Federal Advisory Committee Act (FACA) that provides external advice, information, and recommendations to the Office of Research and Development (ORD). This report has not been reviewed for approval by the U.S. Environmental Protection Agency (EPA), and therefore, the report's contents and recommendations do not necessarily represent the views and policies of EPA, or other agencies of the federal government. Further, the content of this report does not represent information approved or disseminated by EPA, and, consequently, it is not subject to EPA's Data Quality Guidelines. Mention of trade names or commercial products does not constitute a recommendation for use. Reports of the Board of Scientific Counselors are posted on the Internet at https://www.epa.gov/bosc.

# CONTENTS

**INTRODUCTION ..... 1**
Common Themes ..... 1

**BOSC AIR AND ENERGY SUBCOMMITTEE ..... A-1**

**BOSC CHEMICAL SAFETY FOR SUSTAINABILITY/HUMAN HEALTH RISK ASSESSMENT SUBCOMMITTEE ..... B-1**

**BOSC HOMELAND SECURITY SUBCOMMITTEE ..... C-1**

**BOSC SAFE AND SUSTAINABLE WATER RESOURCES SUBCOMMITTEE ..... D-1**

**BOSC SUSTAINABLE AND HEALTHY COMMUNITIES SUBCOMMITTEE ..... E-1**

# INTRODUCTION

The U.S. Environmental Protection Agency (EPA or the Agency) Board of Scientific Counselors (BOSC) provides advice to the Office of Research and Development (ORD) on the creation and implementation of its research programs. These research programs are carried out in support of the Agency's various program and regional offices. The BOSC subcommittees began the process of reviewing the newly developed Strategic Research Action Plans (StRAPs) in the fall of 2018 after the Agency completed the draft StRAPs and the charge questions that would help guide the different subcommittees to review each StRAP. The subcommittees met with senior ORD staff, the National Program Directors (NPDs) responsible for the different StRAPs, Agency research scientists, and program office staff involved in the development of the StRAPs. Each subcommittee developed reports addressing the charge questions and made recommendations for ORD's consideration in finalizing the StRAPs, which are presented in this report.

The BOSC Executive Committee (EC) oversees five subcommittees, including the Air and Energy (A-E) subcommittee, Homeland Security (HS) subcommittee, Chemical Safety for Sustainability/Human Health Risk Assessment (CSS/HHRA) subcommittee, and Sustainable and Healthy Communities (SHC) subcommittee. The EC met in Research Triangle Park, North Carolina, June 27–28, 2019, to review the draft subcommittee reports. The EC also identified common themes identified in the subcommittee reports, which are presented here as the report summaries. The full subcommittee reports are presented as appendices to this EC report. Review of the National Research Program StRAPs

Overall, the subcommittees were impressed with the Agency's responsiveness to stakeholder input as documented in the StRAPs and with the ambitious nature of the proposed high-quality and innovative research. The subcommittees were also impressed with the quality of the research staff.

## Common Themes

**Stakeholder Engagement**

Each subcommittee was asked if their StRAP sufficiently incorporated the input from stakeholders, including EPA regions, states, and tribal communities. The Agency has emphasized the effort to garner this input. The subcommittees believe this engagement should transition to the research implementation planning phase, the conducting of the research, and the research output development with special attention paid to disseminating those outputs to the stakeholders.

**Research Timeframes: Short- Versus Long-Term Research and Outcomes**

The Agency emphasizes shorter-term research with near-term outcomes because of its mission and its various stakeholder interests. However, the Agency must be prepared to address significant unknowns in an unpredictable time frame. The key to success in these situations might be obtaining a substantial foundation of knowledge and experience that often comes from continued longer-term research with longer-term outcomes. All subcommittees urged their research program leadership to consider maintaining an adequate portfolio of longer-term research along with adequate staffing and expertise to enable ORD to cope with emerging issues and unforeseen events and circumstances.

**Conducting Research: Articulating the Mechanisms**

The programs could improve the StRAPs by including a description of the likely mechanism for implementing the identified research. Mechanisms include whether the research is completed by EPA staff alone or in collaboration with others. Collaborators might include other federal agencies, EPA regions, states, or tribal communities. The research might be conducted by outside contractors or through grants to university researchers. These mechanisms should be identified in the next stage of the research process during which the StRAPs are the basis for research implementation plans.

**Exposure Science: In a Real-World Context**

In a real-world setting, organisms are more likely to be exposed to a mixture of chemicals and non-chemical stressors, rather than to single chemical agents. The organisms exposed might include individuals that are more susceptible than others or be at life stages during which they are more or less vulnerable. The effects of these multiple stressors can be cumulative. The StRAPs should include a greater focus on these real-world exposure scenarios.

**Gaps in Research: Emerging Materials and Chemicals**

Because EPA has access to the literature on chemicals and materials that have not been the subject of its own research, the Agency can use all in-depth research on a given chemical to extrapolate to related chemicals and should explicitly consider examining emerging materials—including those on pharmaceuticals, hormones, nanomaterials, and micro plastics—regularly.

**Tools**

The Agency is succeeding in driving the development of "next generation" tools and models for monitoring and assessment of hazards, exposure, health effects, sustainable systems, and homeland security. EPA should continue this emphasis while also increasing focus on stakeholder awareness of these tools and models and on training stakeholders in their use.

**Climate Effects**

The short- and long-term effects of climate change will act as stressors on ecological systems and communities; in addition, assessment endpoints are also likely to change as the climate changes. These effects should be considered in the development of tools and models. The work of other agencies and investigators on climate change effects should be incorporated into EPA's research.

**Metrics: Measures of Success**

All subcommittees stressed the emphasis on the development of metrics for monitoring the progress of the proposed research and the utility of its outcomes for stakeholders. The Agency should focus on metrics during the implementation phase for all StRAPs.

**Social and Behavioral Science**

Subcommittee members noticed a de-emphasis of social and behavioral sciences in the StRAPs. The subcommittees emphasized the importance of incorporating social and behavioral sciences for identifying the Agency's research needs, developing appropriate tools and models, and assisting user decision-making. Focusing less on social and behavioral sciences should not transition to the implementation plans.

**Innovation**

The subcommittees responded to the request for ideas on innovation with numerous suggestions. They ranged from encouraging the use of proven mechanisms like Small Business Innovative Research (SBIR) grants, grants through the Science to Achieve Results (STAR) program, and newer, less utilized approaches like "grand challenge" rewards.

**Workforce Development**

To maintain the leading edge of ORD's mission to provide the research necessary to protect environmental and ecological health, ORD must conduct research to attract and retain the most prestigious scientists and engineers. ORD must also consider programs for professional development, continuing education, workforce planning, and succession planning.

BOSC
BOARD OF SCIENTIFIC COUNSELORS

# REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

## BOSC AIR AND ENERGY SUBCOMMITTEE


Charlette Geffen, Ph.D. (Chair)
*Pacific Northwest National Laboratory*

Sandra Smith, M.S. (Vice Chair)
*Retired*

Viney Aneja, Ph.D.
*North Carolina State University*

Jeffrey Arnold, Ph.D.
*U.S. Army Corps of Engineers*

Bart Croes, P.E., M.S.
*Retired*

Jennifer Hains, Ph.D.
*Minnesota Dept of Health*

Cara Keslar, M.S.
*Wyoming Dept of Environmental Quality*

Michael Kleinman, Ph.D.
*University of California, Irvine*

Myron Mitchell, Ph.D.
*State University of New York*

Louie Rivers III, Ph.D.
*North Carolina State University*

Annette Rohr, Sc.D.
*Electric Power Research Institute*

Constance Senior, Ph.D.
*Clean Energy*

Art Werner, Ph.D.
*Retired*


EPA Contact
**Tom Tracy, Designated Federal Officer**

August 19, 2019

Disclaimer Text. This report was written by the Air and Energy (A-E) subcommittee of the Board of Scientific Counselors, a public advisory committee chartered under the Federal Advisory Committee Act (FACA) that provides external advice, information, and recommendations to the Office of Research and Development (ORD). This report has not been reviewed for approval by the U.S. Environmental Protection Agency (EPA), and therefore, the report's contents and recommendations do not necessarily represent the views and policies of EPA, or other agencies of the federal government. Further, the content of this report does not represent information approved or disseminated by EPA, and, consequently, it is not subject to EPA's Data Quality Guidelines. Mention of trade names or commercial products does not constitute a recommendation for use. Reports of the Board of Scientific Counselors are posted on the Internet at http://www.epa.gov/bosc.

# CONTENTS

**LIST OF ACRONYMS** ..... **A-4**

**INTRODUCTION** ..... **A-5**

**BACKGROUND** ..... **A-5**

**STRAP RESEARCH OBJECTIVES** ..... **A-6**

**CHARGE QUESTIONS AND CONTEXT** ..... **A-8**

**SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS** ..... **A-9**
Charge Question 1a ..... A-10
Charge Question 1b ..... A-13
Charge Question 1c ..... A-15
Charge Question 1d ..... A-19
Charge Question 1e ..... A-22

**SUMMARY LIST OF RECOMMENDATIONS** ..... **A-26**

**CONCLUSIONS** ..... **A-27**

**APPENDIX A: MEETING AGENDA** ..... **A-30**

**APPENDIX B: MATERIALS** ..... **A-31**
Material Provided in Advance of the Meeting ..... A-31
Additional Material Provided During the Meeting ..... A-31

## LIST OF ACRONYMS

| | |
|---|---|
| AAPCA | Association of Air Pollution Control Agencies |
| ACE | Air, Climate, and Energy |
| A-E | Air and Energy |
| AMD | Atmospheric Model Development |
| BenMAP | Benefits Mapping and Analysis Program |
| BOSC | Board of Scientific Counselors |
| CAA | Clean Air Act |
| CARB | California Air Resources Board |
| CENRAP | Central Regional Air Planning Association |
| CENSARA | Central States Air Resource Agencies |
| CMAQ | Community Multiscale Air Quality Modeling System |
| CSS | Chemical Safety for Sustainability |
| DOE | Department of Energy |
| ECOS | Environmental Council of the States |
| ERIS | Environmental Research Institute of the States |
| EPA | U.S. Environmental Protection Agency |
| FY | Fiscal year |
| HAP | Hazardous air pollutant |
| HHRA | Human Health Risk Assessment |
| HSRP | Homeland Security Research Program |
| ITRC | Interstate Technology and Regulatory Council |
| LADCO | Lake Michigan Air Directors Consortium |
| MARAMA | Mid-Atlantic Regional Air Management Association, Inc. |
| MJO | Multi-jurisdictional organization |
| MBI | Market-based research |
| NACAA | National Association of Clean Air Agencies |
| NAAQS | National Ambient Air Quality Standards |
| NASA | National Air and Space Administration |
| NERL | ORD's National Exposure Research Laboratory |
| NESCAUM | Northeast States for Coordinated Air Use Management |
| NGO | Non-governmental organization |
| NTAA | National Tribal Air Association |
| ORD | EPA's Office of Research and Development |
| PFAS | Per- and polyfluoroalkyl substances |
| PM | Particulate matter |
| RTP | Research Triangle Park |
| SBIR | Small Business Innovation Research |
| SHC | Sustainable and Healthy Communities |
| SSWR | Safe and Sustainable Water Resources |
| STAR | Science to Achieve Results |
| StRAP | Strategic Research Action Plan |
| WESTAR | Western States Air Resources Council |

## INTRODUCTION

The mission of the U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) is to provide the best available science and technology to inform and support public health and environmental decision-making at the federal, state, tribal, and local levels, addressing critical environmental challenges and anticipating future needs through leading-edge research. The ORD's Air and Energy (A-E) research program focuses on the science and engineering needed to improve air quality, reduce the number of nonattainment areas in the United States, and protect public health and the environment. It is one of the Agency's six, highly integrated national research programs. The other five are Chemical Safety for Sustainability (CSS), Homeland Security Research Program (HSRP), Human Health Risk Assessment (HHRA)[now Health and Environmental Risk Assessment, HERA], Safe and Sustainable Water Resources (SSWR), and Sustainable and Healthy Communities (SHC).

ORD has developed Strategic Research Action Plans (StRAPs) to guide each research program. The draft A-E Strategic Research Action Plan, 2019–2022 (A-E StRAP)[1] articulates a four-year strategy for delivering air- and energy-related research to address EPA's strategic objectives and mandates, as identified in the FY 2018–2022 EPA Strategic Plan (EPA Strategic Plan)[2]. It is the third such Strategic Planning exercise in this format (previous StRAPs covered 2012–2016 and 2016–2019). The current StRAP evolved through close collaboration with EPA program and regional partners, input from the EPA laboratories and centers working with A-E, consultation with the states to identify their needs, particularly through the Environmental Council of the States (ECOS), and engagement with the tribes.

Currently, ORD is seeking input from the Board of Scientific Counselors (BOSC) on the draft 2019–2022 StRAP documents and proposed research strategies. The emphasis is on advancing ORD research that can successfully address the needs identified by EPA programs and regions, states, and tribes. This review by the BOSC A-E subcommittee is focused on strategic directions and proposed research priorities described in the draft A-E StRAP. Future BOSC reviews will address research activities and outcomes over the course of the StRAP implementation.

## BACKGROUND

In November 2018, A-E provided the BOSC A-E subcommittee with review materials relating to the draft A-E StRAP and five charge questions to consider when reviewing the materials. Subsequently, the A-E subcommittee:

**1.** Reviewed the draft StRAP (October 24, 2018 version) and related materials (see Attachment B for list of materials);
   a. Met with the A-E Acting National Program Director and program staff on November 13–14, 2018 in Research Triangle Park (RTP), North Carolina. In addition to A-E presentations, the subcommittee had opportunities to discuss elements of the plan with program staff (see Attachment A for meeting agenda);

.....

[1] Air and Energy National Research Program, *Strategic Research Action Plan, 2019 – 2022*, External Review Draft, October 24, 2018 version. Updated: March 11, 2019 version.

[2] Working Together, FY 2018-2022 U.S. EPA Strategic Plan, available at https://www.epa.gov/planandbudget/strategicplan

b. Deliberated as a group on the charge questions; and
c. Divided into five sub-groups to draft initial responses to each charge question.

The five subcommittee workgroups drafted specific responses to each charge question after the November 2018 meeting. The Chair and Vice Chair of the subcommittee prepared an initial draft of the subcommittee report based on charge question responses provided by the five small groups, circulated the initial draft report to all subcommittee members, asked for review comments, and planned a teleconference for March 22, 2019 to discuss the draft report.

Prior to the teleconference, EPA released a revised draft StRAP (March 11, 2019 version) that reflected some of the feedback and discussion at the November 2018 meeting. As a result, several recommendations or suggestions made in an earlier draft of the subcommittee report were no longer necessary and were removed from the report. These included recommendations to more comprehensively identify state and tribal research needs in the StRAP and to provide a more detailed description of the aims and expected products of critical extramural programs. For the same reason, a suggestion to better articulate anticipated research outcomes was also deleted. Some recommendations were moved from the list of recommendations to text discussion or included as suggestions.

The report was further revised based on subcommittee member comments and discussions during the teleconference on March 22, 2019. The recommendations of the A-E subcommittee in the draft report are based on material provided to us prior to and after the November 2018 meeting, presentations made during the day and a half meeting, and deliberations during the meeting and after the meeting in teleconference.

The draft report was submitted to the full BOSC Executive Committee, which met in June 2019 in RTP, NC to review and discuss draft reports from each of the ORD BOSC subcommittees. The Chair, Vice Chair, and Dr. Viney Aneja of the A-E subcommittee are members of the Executive Committee; Dr. Charlette Geffen and Dr. Aneja participated in the meeting. The A-E Acting National Program Director, Dr. Alan Vette, was present. They and the members of the BOSC Executive Committee discussed the A-E subcommittee draft report during the meeting, asked clarifying questions, provided perspective, and offered comments to the A-E subcommittee Chair and Vice Chair.

Subsequently, the A-E subcommittee Chair made minor revisions to the draft report in response to questions and comments raised during the BOSC Executive Committee meeting, as well as the additional information provided during the meeting, and submitted this revised report back to the Executive Committee for their final review.

## STRAP RESEARCH OBJECTIVES

The draft A-E StRAP outlines research to address EPA's strategic objectives and mandates to improve air quality, reduce the number of areas currently in nonattainment of the National Ambient Air Quality Standards (NAAQS), and protect public health and the environment. As described in the draft StRAP, the A-E research objectives are for FY 2019–2022 are:

> **Assess Impacts** — Improve understanding of the processes regulating human and ecosystem exposures and of the effects associated with air pollutants at individual, community, regional, national, and global scales.

**Expand Approaches to Prevent and Reduce Emissions** — Develop and evaluate new approaches to prevent and reduce air pollution now and in the future, particularly sustainable, cost-effective, and innovative multi-pollutant and sector-based approaches.

**Advance Measurement and Modeling** — Improve the human exposure and environmental modeling, monitoring, metrics, and information that are needed to address emerging and future risks and inform air quality decision making at the national, state, tribal, and local levels.

**Inform Decisions** — Deliver state-of-the-art science and tools to inform implementation of the NAAQS and other air quality regulations and policies at the national, state, tribal, and local levels.

To achieve these objectives and more clearly align with the EPA Strategic Plan, the A-E research program is updating its structure to organize research activities under three interrelated topics: (1) Science for Air Quality Decisions; (2) Extreme Events and Emerging Risks; and (3) Next Generation Methods to Improve Public Health and the Environment. Although many scientific issues cut across all three research topics, one in particular – wildland fires – highlights the importance of an integrated science focus and has been identified separately, as it will draw from activities in all three topic areas. The integration of research on wildland fires across the three main topics provides a guide to integrated research for other scientific issues that cut across more than one topic. The following figure is a conceptual diagram from the draft StRAP that illustrates the updated organizational structure of the A-E program.

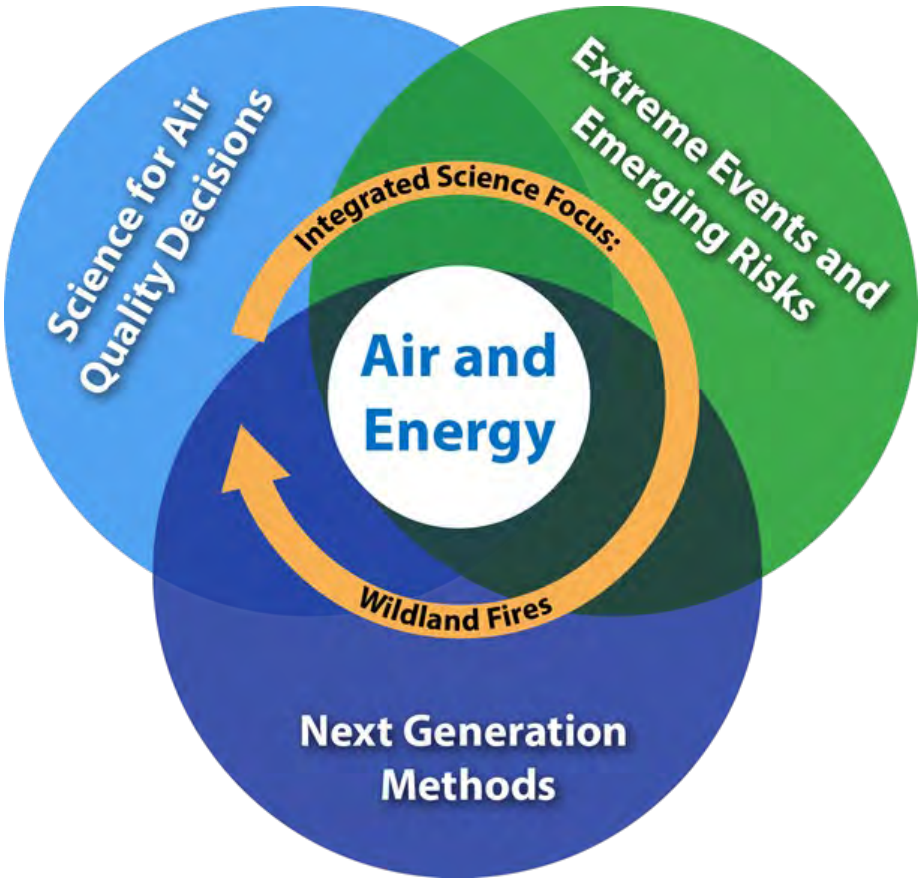


**Figure 1. A-E Research Topics**

The draft A-E StRAP further subdivides each of the three high-level research topics into eight research areas, plus the integrated research area focused on wildland fires. The following table from the draft StRAP is an overview of the A-E program structure, with three research topics and nine research areas.

**Table 1. Overview of the A-E Research Program Structure**

| Topic | Research Areas | |
|---|---|---|
| **Science for Air Quality Decisions** | #1: Approaches to support air quality management programs for multiple pollutants at multiple scales | #9: Wildland Fires (Integrated Science Focus) |
| | #2: Approaches for characterizing source emissions, air quality, exposure, and mitigation strategies | |
| | #3 Public health and environmental responses to air pollution | |
| **Extreme Events and Emerging Risks** | #4: Public health and ecosystem exposures and responses to emerging air pollutants and sources | |
| | #5: Methods to evaluate environmental benefits and consequences of changing energy systems | |
| | #6: Methods to enable resilience to future environmental stressors | |
| **Next Generation Methods to Improve Public Health and the Environment** | #7: Emerging approaches to improve air quality and exposure characterization | |
| | #8: Novel approaches to assess human health and ecosystem impacts and risks | |

Appendix 1 of the draft StRAP lists 29 proposed, high-level research outputs, including proposed delivery time frames, organized by Topic and Research Area. Outputs are defined as deliverables with the research results synthesized and/or translated into the format needed by the end user(s). The A-E program plans to maintain engagement with partners throughout the research process to optimize the utility of the research products to meet their needs.

## CHARGE QUESTIONS AND CONTEXT

The A-E subcommittee was charged with five questions as follows:

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?
>
> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which

are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any *other critical emerging* environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

These same five charge questions were posed to each of the BOSC subcommittees to guide their review of the ORD draft StRAPs. The responses of the A-E subcommittee to the charge questions are contained in the following section.

## SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

The subcommittee appreciates the efforts of the A-E program leadership and staff to develop and deliver a StRAP that builds on the history of important scientific contributions in the program and positions the A-E research enterprise for effective scientific advances in the context of evolving Agency priorities. The research topics identified are based on important science challenges and are well suited to the program's strengths. The plan also allows for opportunities to address complex and/or emerging scientific issues with a systems approach, as demonstrated by the cross-cutting design of the wildland fires research area. Continued attention to development of the workforce of the future is suggested to position the program for future success. The A-E program has made changes to the engagement process for identifying partner and stakeholder needs and is encouraged to update the StRAP to more clearly represent the attention to outreach and dialogue that is continuing to be an important part of the program. The A-E program vision, while well-articulated in this StRAP, should be carefully implemented with review to ensure that research work for immediate and short-term responses do not become the sole focus or goal of A-E research activities. To continue its record of success, A-E work must be a balance of the interests of EPA partners inside and outside the labs with those of the wider A-E science research communities. Striking the proper balance of work for immediate Agency responses and a commitment to longer-term research on topics relevant to A-E missions and goals will help ensure that A-E and ORD as a whole can continue leading advancements in environmental science. Clearer articulation of the applied science questions that could drive new A-E research, and how those research areas are aligned with A-E scientific strategy and research priorities, would help ensure a balanced approach in A-E's research plan and agenda.

The StRAP should provide a more detailed description of the aims and expected products of the extramural research programs which are an integral part of the A-E research agenda. This description will help ensure a more comprehensive view of the research program. The subcommittee also encourages A-E to include potential issues related to energy – currently the "E" in A-E is underrepresented. These issues certainly represent critical emerging needs in environmental science. Examples are provided in the report

on where proactive research could inform important scientific questions. The A-E StRAP should also explicitly include environmental justice and citizen science topics that are important to regional, state, local and tribal agencies, and the public at large, and potentially include energy and environmental justice as cross-cutting research issues in Appendix 3 of the StRAP. Given the challenging funding environment, the use of a variety of approaches to advance solutions is recommended. The subcommittee suggests focused utilization of the EPA Small Business Innovation Research (SBIR) program (perhaps around specific challenges to develop Next-Gen answers to emerging environmental problems) as one approach, as well as a focused call using the Science to Achieve Results (STAR) program, which could be utilized for attacking an emerging environmental challenge. Finally, broader use of interagency partnerships and collaborations is recommended to maximize efficiencies and make the best use of intellectual and physical capital.

Specific responses to each of the five charge questions follow below. The responses highlight strengths of the plan as identified by the subcommittee, as well as suggestions for additions or clarifications to the plan that might reinforce plan priorities and/or enhance understanding of ongoing activities and initiatives. The responses also include one or more specific recommendations for action by the A-E program leadership and staff for each charge question.

## Charge Question 1a

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

**Narrative**

The EPA Strategic Plan is largely mission-oriented. As stated directly in the plan, it emphasizes a "back-to-basics" agenda with three overarching goals: *1) refocus the Agency on its core mission (deliver real results to provide Americans with clean air, land, and water, and ensure chemical safety); 2) restore power to the states through cooperative federalism (rebalance the power between Washington and the states to create tangible environmental results for the American people); and 3) lead the Agency through improved processes and adhere to the rule of law (administer the law as Congress intended, to ensure the Agency is focused on its statutory obligations under the law).*

The ORD Strategic Plan[3] focuses on how to operate within ORD to achieve the overall EPA mission. It outlines how ORD plans to ensure that its science is well formulated, focused on priority issues, conducted in a manner consistent with scientific protocols and guidelines, and accessible to the public in a way that is both transparent and understandable.

The subcommittee has identified the following strengths concerning the alignment of the research outlined in the draft StRAP with relevant Agency priorities as described in the EPA and ORD Strategic Plans and provides additional suggestions and recommendations for A-E Program leadership consideration.

**Strengths**

- There is a clear relationship between the outlined research and the EPA Strategic Plan Goal 1: Core Mission, Objective 1.1, "Improve Air Quality". This approach has historically been a major priority for the A-E program research agenda, with important outcomes, and will continue to be a key element of the program moving forward.

.....

[3] EPA, Office of Research and Development, Strategic Plan 2018–2022, available at https://www.epa.gov/research/epa-office-research-and-development-strategic-plan-2018-2022

- The draft StRAP does a good job tying research priorities to the appropriate regulatory drivers and policy context, providing links to the relevant regulations and strong justification for the research agenda described in the plan.
- With respect to alignment with Goal 2: Cooperative Federalism, the StRAP highlights significant efforts that the A-E staff has engaged in to meet this goal. In each research area, external needs are identified as context and drivers for the outlined research program.
- The broad portfolio of the program includes both intramural and extramural research activities. One example of extramural research discussed at the BOSC meeting focused on research centers looking at the issue of exposure to multiple pollutants. This is a good example of extramural research contribution to the A-E portfolio that aligns well with the EPA core mission as well as regulatory compliance work.
- Specific outputs for each research area were provided in the plan, which is aligned with the EPA approach of using more measurements and metrics to highlight the value of its research and the accomplishments of its research programs. Appendix 1 of the draft plan summarizes specific outputs for each research area.
- Overarching wildland fire/biomass burning research intersects with all three research topics and most of the research areas. It is a good example of a systems approach to important and/or emerging questions or issues that do not fit neatly into just one of the research topics. The increasing complexity of environmental issues will continue to demand this integration.

**Suggestions**

The following suggestions for modification of the StRAP are provided to better highlight alignment of the research outlined in the draft StRAP with relevant Agency priorities.

- Material in the StRAP itself should be expanded to more clearly show the breadth of the engagement with partners and stakeholders. Program leadership and staff have emphasized the need to continue to engage in communications and dialogue throughout the development and implementation of the StRAP. See response to Charge Question 1b for discussion concerning how well the proposed research program responds to partners' needs.
- The subcommittee believes that the draft StRAP misses an opportunity to highlight alignment with EPA Strategic Plan Goal 3: Rule of Law and Process, Objective 3.5 "Improve Efficiency and Effectiveness". Delivering "on-demand" data to the right people at the right time, the grants processes, and information management are specifically described in the EPA Strategic Plan as central to meeting this objective. The A-E program clearly has some processes in place that can contribute to this goal. The subcommittee suggests the StRAP could better highlight how the program will "acquire, generate, manage, use, and share information" to more clearly demonstrate alignment with this EPA goal.
- The subcommittee encourages A-E to include more discussion in their plan about the workforce requirements and workplace enhancements to implement the action plan. This will provide stronger alignment with ORD Goal 3: Enhancing the Workforce and Workplace. Recognizing that there has been significant attrition in A-E staff, some priority on building and supporting the workforce and work environment would be helpful. The subcommittee appreciates that this is a challenge given ongoing budget constraints, but also believes this is an important priority for the future. Creative approaches to engaging in partnerships with other ORD programs and/or extramural research institutions might be considered.
- While the subcommittee believes that there is good alignment between the research outlined in the draft StRAP with relevant Agency priorities as described in the EPA and ORD Strategic Plans,

the structure of the draft StRAP does not make the alignment clear. See response to Charge Question 1c for discussion of this issue.

- The subcommittee recognizes that the contents of Appendix 1 are not intended to be exhaustive or final. As A-E finalizes the outputs, we encourage the program to continue its focus on alignment with ORD's translational science goals.
- We encourage the A-E program to ensure that scope is maintained for exploratory research in their strategic action plan to enable the Agency to respond to emerging issues. The pace of scientific discovery continues to accelerate, and the problems of tomorrow are likely to be more complex and challenging than those currently known. It is critical that the action plan has some level of flexibility built in to evaluate, identify and pursue emerging scientific challenges that are aligned with EPA's primary mission and vision.

## Recommendations

The subcommittee offers two recommendations to capitalize on opportunities to demonstrate how the research outlined for the 2019–2022 timeframe supports the relevant Agency priorities as described in the EPA and ORD Strategic Plans.

**Recommendation 1a.1:** Identify and describe in the StRAP the process by which A-E will balance immediate needs within EPA and longer-term, exploratory research objectives so that A-E and ORD can be prepared for future science needs. The action plan should include a process for review and evaluation of this balanced approach.

*EPA Response: ORD agrees that research to address both immediate needs and longer-term needs are important components of the Air and Energy research portfolio. As we implement the StRAP, we are balancing the portfolio to address both short-term and long-term needs identified through continued engagement with EPA programs and regions, states, and tribes, and through active engagement with the external stakeholder and academic communities, including the NASEM, to anticipate future environmental challenges. We have added text under the Program Design section that describes the need to periodically review science topics and research areas to evaluate the evolution of science and identify opportunities for new technical approaches to environmental problems, science questions, and new ways of thinking about problems.*

**Recommendation 1a.2:** Add discussion in the StRAP to reflect activities by A-E (current and planned) concerning EPA Strategic Plan Objective 3.5 "Improve Efficiency and Effectiveness", and ORD Goal 3: Enhancing the Workforce and Workplace.

*EPA Response: Thank you for highlighting the importance of efficiency, effectiveness, and workplace enhancement. These important considerations are primarily addressed during research implementation, rather than during strategic planning and StRAP development. A-E's input to ORD's workforce planning focuses on identifying current and anticipated future research needs based on interactions with our partners, as indicated in the ORD Strategic Plan Objective 3.3 ("…align staff with research priorities…"). Metrics to track research implementation remain an Administration emphasis, and we have added a short discussion of EPA Strategic Plan Objective 3.5 onto the Research to Support the EPA and ORD Strategic Plans section.*

## Charge Question 1b

Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

**Narrative**

ORD, and in particular the A-E national research program, has made changes to the engagement process used to incorporate the needs of stakeholders and partners into the Strategic Planning process. ORD has long had relationships with the Agency's program and regional offices but has not engaged as much with other groups (e.g., states, tribes). There is clear intent to interact more broadly with a wide variety of stakeholders in developing and implementing the StRAP over the next few years, rather than focusing only on the partner organizations within EPA. Within ORD, A-E has made a good initial start by looking at ECOS and the National Tribal Air Association (NTAA) air quality priorities. The StRAP reflects the needs identified [to date] by programs, regions, states, and/or tribes within each research area. The subcommittee encourages A-E to continue to engage with these groups and others, and specifically continue conversations with the states, as it refines the StRAP and implements the action plan. This is a long-term project of building relationships, and it is helpful to have a strategy for further developing processes and to have metrics to assess progress in this endeavor.

In response to the charge question, the subcommittee considered how the engagement process is explained in the draft A-E StRAP, whether A-E is responding to the needs identified, and whether there are partners or stakeholders that require additional outreach.

The subcommittee has identified the following strengths concerning the engagement process and the alignment of the research outlined in the draft StRAP with partner-identified needs and provides additional suggestions and recommendations for A-E program leadership consideration.

**Strengths**

- The presentations and discussion at the BOSC meeting demonstrated that A-E has accomplished significant outreach and engagement with a variety of stakeholders, although not all of these efforts are clearly reflected in the draft StRAP. Reaching out to external partners is an important element of EPA's outreach, and we encourage the A-E program leadership and staff to identify approaches that will enable them to continue dialogue with these groups.
- Appendix 2 in the StRAP provides a high-level summary of the needs of states and tribes. Additional information on needs of states and tribes was also identified in the draft StRAP within each research area. The StRAP report responds to the needs that were identified.
- The plan identifies key issues and outputs that build on the technical expertise and foresight of A-E, and at the same time, provide great benefit to external partners (states and tribes, for example) who do not have the resources or technical staff to fully articulate and respond to emerging issues (e.g., per- and polyfluoroalkyl substances, or PFAS). When problems come up, these stakeholders need EPA to help mobilize resources and talent to rapidly provide assistance.

**Suggestions**

- We encourage A-E to continue discussion with tribes and states, using the process outlined in Dr. Alan Vette's presentation to the subcommittee. It can be helpful to have separate discussion with

tribal organizations to ensure that their voices are heard. In addition, A-E should commit to ongoing communication and updates with the states, tribes, and other external partners as the research topics and projects are refined.

- The draft StRAP made a good start at identifying partner and stakeholder needs, but it would be helpful to expand on how those needs will be addressed and how A-E will continue to refine its understanding of the needs. A process for prioritizing needs as well as checking back with partners to see if new needs are identified would be useful to summarize in the action plan.
- The draft StRAP misses an opportunity to highlight the extensive A-E outreach efforts to date and the connection between outreach and program design. The subcommittee suggests adding detail on the process of engagement and commitment to continuing dialogue as discussed in the recommendations. Slide 38 in Alan Vette's presentation to the subcommittee ("Input from outside stakeholders") should be included in the StRAP as a means to summarize how A-E connected with the outside stakeholders.
- Reaching out to ECOS is a good first start but this group represents a high-level view from state agencies. The subcommittee suggests that A-E consider reaching out to the National Association of Clean Air Agencies (NACAA), the Association of Air Pollution Control Agencies (AAPCA), and multi-jurisdictional organizations (MJOs) to allow for more granularity of the issues. The MJOs have good relationships among states and provide more regional perspective from states because they don't require consensus from the larger group (NACAA/AAPCA). Some examples of MJOs are MARAMA, WESTAR, NESCAUM, LADCO, CENSARA, CENRAP, CARB, and NTAA.[4]
- The program could leverage the existing relationship with ECOS to include more specific questions (items) about emerging needs from the states on the Environmental Research Institute of the States (ERIS) States' Research Needs Survey. ORD and A-E can also make use of the regional offices' connections to the states and local organizations to identify emerging needs.
- As A-E formulates its research priorities and plans, engaging more intentionally with MJOs as research partners could be valuable. Formalized procedures for engaging in conversation with MJOs are recommended; for example, make technical presentations to MJOs on A-E research programs and facilities and connect A-E principal investigators with specific organizations/individuals on projects.
- A-E creates the A-E research news quarterly web newsletter and science matters newsletter and these are great resources. These resources should be highlighted in the StRAP as part of the overall A-E strategic outreach and engagement plan, and could also be advertised more to states, MJOs, non-governmental organizations (NGOs), academia and trade groups.

## Recommendations

The subcommittee offers these recommendations concerning the engagement process and the alignment of the research outlined in the draft StRAP with partner-identified needs.

**Recommendation 1b.1:** There is a need to have more engagement with states and tribes, in particular, educational outreach on A-E capabilities. It would also be helpful to educate partners on the kinds of questions EPA can answer. For example, EPA staff might attend MJO meetings (in person or via webinar) to present ORD capabilities and then ask questions of states' needs. This can be a good mechanism for identifying emerging issues.

.....

[4]The full list of acronyms can be found on page 4.

*EPA Response: ORD agrees that planned engagement with EPA programs and regions, states, tribes, and other stakeholders throughout the process of planning, implementing, and delivery of research is necessary and beneficial to the research process. The Air and Energy Program is committed to this engagement process. We are reaching out to multi-jurisdictional organizations, such as the Association of Air Pollution Control Agencies (AAPCA), the EPA Tribal Science Council, and other state and regional organizations. We also continue to receive input through the Environmental Research Institute of the States (ERIS), which helps to identify emerging issues where ORD research may contribute. We have also added text to the Engagement with Partners and Stakeholders section that provides examples of specific planned engagement activities. We are also developing a strategic plan for engagement during research implementation and delivery of research results. We will be happy to share a summary of that plan with the BOSC once it has been completed.*

**Recommendation 1b.2:** Academia, science associations etc. are mentioned in the draft StRAP, but it would be helpful to discuss in more detail how these outreach efforts occur and are utilized by EPA. NGOs are not discussed and should be included (unless they are considered community action groups).

*EPA Response: ORD agrees that NGOs can provide valuable inputs and potential collaborations. We have added additional language to the Topic 3 section discussing how NGOs, community organizations, and individual citizen scientists have contributed to the success of the Air and Energy research program. As we implement the StRAPs, several of the planned research activities include direct collaboration with NGOs and citizens, and we anticipate that these collaborations will result in unique and valuable scientific contributions. One relevant example is the Wildfire Solutions-Driven Research project, which is a collaborative effort between ORD, the Missoula City-County Health Department, Climate Smart Missoula, the University of Montana, and the Hoopa Valley Tribe. In this project, ORD scientists are working directly with the organizations to use low-cost air quality sensors to evaluate various filtration systems for use in establishing clean air spaces where community members can go to reduce exposures to poor air quality during wildfire smoke episodes.*

**Recommendation 1b.3:** We encourage continued collaboration and communication through sensor workshops/wildfire workshops and including communities involved in these issues to be a part of the workshops.

*EPA Response: ORD agrees that continued collaboration and communication around issues related to sensors and wildfires through workshops are appropriate. Recently we have conducted a workshop on performance targets for air quality sensors (https://www.epa.gov/air-research/deliberating-performance-targets-air-quality-sensors-workshops) and a web summit on indoor air filtration to protect public health during wildland fire smoke episodes (http://www.epa.gov/air-research/web-summit-presentations-clean-air-spaces-indoor-air-filtration-protect-public-health). Academics, other professionals, and community members took part in each of these workshops. Over forty percent of participants in the air filtration web summit were not associated with federal or state government agencies.*

## Charge Question 1c

Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

**Narrative**

The draft A-E StRAP provides a summary of topics, research needs, and outputs related to energy and the atmosphere, including the role of EPA in helping improve air quality, that clearly describe the strategic vision of the program. The A-E strategic vision directly addresses a subset of the vision of the entire EPA program, as indicated by yellow ovals in the figure below:

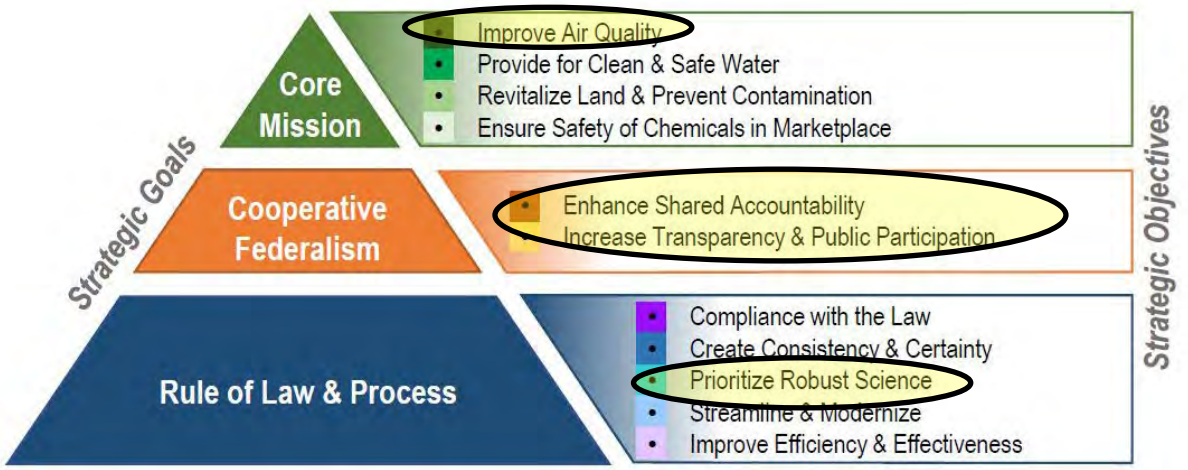


**Figure 2. EPA Strategic Plan (FY 2018–2022)**

The engagement of A-E partners in the development of the StRAP will facilitate the distribution of information related to air pollution and the other goals and objectives in the 2018–2022 EPA Strategic Plan. This broader participation should also encourage individuals to provide feedback on a variety of topics related to air pollution, including emerging measurement techniques, newly identified pollutants, methodology for pollution reduction, etc.

The subcommittee understands that this plan is strategic, and not an implementation or action plan. The subcommittee commends A-E for setting forth ambitious goals in the draft StRAP, some of which (e.g., the role of forest and wildland fires in air pollution) will likely extend beyond 2022. The StRAP provides a good start in addressing science questions under the broad themes of A-E research. The work on forest and wildland fire is especially highly relevant and well-developed. The A-E Program is supporting work at ORD's National Exposure Research Laboratory (NERL) Atmospheric Model Development (AMD) Branch, for example, that could help advance air pollution modeling related to the research area of wildland fire, especially if additional resources are available. The plans for forest and wildland fire work described in the draft StRAP should also provide an opening for continued testing of new and improved sampling methods, including satellite remote sensing of forest fire characteristics such as burn area, etc., under a broad range of conditions relevant to many areas of importance to regional and local policies. We applaud the effort of A-E in bringing together this draft StRAP that clearly demonstrates EPA's continued support of scientific research and overall environmental efforts related to atmospheric pollution and energy utilization in the United States.

Communication mechanisms associated with the StRAP must be carefully designed and implemented to be supportive of the science conducted in the A-E program. The first stages of communication developments are described in the draft StRAP for making desired information available. However, the tasking for information sharing should not distract from the core scientific mission of EPA ORD A-E. The

A-E subcommittee recognizes that EPA is working under conditions of limited resources and that priorities need to be clearly delineated to maximize the effectiveness of chosen communication mechanisms.

The draft StRAP also shows a substantial commitment to both enhanced shared accountability and increases in transparency and participation by a range of partners. Ongoing engagement with various partners will encourage understanding and support for the scientific approaches used in regulatory and specialized monitoring air quality and the reduction of air pollution to meet EPA and ORD Strategic Plan objectives. Feedback from the partners identified in the StRAP will encourage and strengthen relationships at A-E that will be helpful in meeting EPA objectives for monitoring and decreasing air pollution and help shape current and future activities.

The subcommittee has identified the following strengths concerning the strategic vision of the program, and the extent to which the StRAP provides a structure for making progress toward outcomes in the 2019−2022 time frame and provides additional suggestions and recommendations for A-E program leadership consideration.

**Strengths**

The draft StRAP provides an excellent general summary of topics and research areas for the A-E national program and the A-E program vision. It sketches a coherent general structure for progress against those topics and the larger general ORD and EPA objectives and goals. The document shows the importance of addressing issues related to energy utilization and air quality and sketches the general picture of how these research areas are related and are mutually reinforcing. The A-E research vision is appropriately ambitious and thoughtfully built on well-known historical successes in Air, Climate, and Energy (ACE) and ORD; this is an excellent template for the A-E programs.

- The additional emphasis in this draft StRAP on planning for greater participation of partners from diverse groups (other governmental agencies, industry, scientific groups, NGOs, states and tribes), and on related translation of A-E science products for informing decisions, are very positive aspects of this plan.
- The draft StRAP shows that effective and efficient environmental policy must be built from well-established science with the flexibility to respond to any future policy-relevant questions. This policy needs to address known environmental and energy components, recognizing the relative importance of these components in the United States will change. The protection of human and ecosystem health depends on the ability of A-E to marshal science to account for effects of those changes, many of which are currently unknown.
- The draft StRAP thoughtfully shows points of possible integration of intra- and extramural research on A-E topics.

**Suggestions**

- The present draft StRAP document could benefit from the development of a listing (possibly a table) that would show priorities and how they fit into the overall vision of EPA and the StRAP.
- Mechanisms could be developed through internal collaboration with EPA offices which receive science products from A-E to facilitate access of those A-E partners to the data sets, reports, papers, etc., as well as in the translation of those science products to help make decisions informed by the best A-E science outputs. Providing general and flexible timelines for the major components of the plan would be helpful for demonstrating the connections from A-E science to the partners identified in the StRAP. The inclusion of further consideration of the use of a system's

approach to help integrate the various components, including the social aspects, would be helpful.

- Particular research lines could be described in slightly more detail as a means to illustrate where, for example, the air pollution and energy resource components of A-E could be brought together to show how this work advances the science of each component relevant to EPA and its partners.
- The plan needs clearer articulation of the applied science questions that will drive new research for A-E to meet its obligation to remain at the forefront of environmental science research relevant to EPA's missions. An explicit systems integrative approach as suggested above will help illustrate and delineate separate lines of research and where and how those lines cross to enhance the usefulness of work on each applied science question to A-E and ORD.
- More specific descriptions of formalized procedures for producing and iterating science research questions need to be provided along with identification of the impacted scientific communities. These questions should be dedicated to protecting the A-E aspects of human health and the environment. Better articulation of these questions would more strongly tie them to the general EPA Strategic Plan objectives.
- The subcommittee has some concern that the draft StRAP sourcing of research ideas is too far in the direction of A-E's partners and product end-users, leaving insufficient attention to the environmental science research communities relevant to work under the specific A-E components of ORD. The continued close integration of A-E with the wider atmospheric and energy research communities outside EPA is vital to ensuring that ORD can maintain its position of advancing environmental science. An element of a more inclusive approach could be articulation of a process for identifying and prioritizing work preparing for future 'unknown unknowns'.
- A clearer description of specific motivating science questions and why the A-E program is best suited to answer those questions would strengthen the connection of A-E work to the ORD goal of remaining at the forefront of environmental science research. The science challenges outlined early in the plan may be a part of this motivation, but they are organizationally removed from the specific research topics and areas in the StRAP. This added description would improve the utility of the StRAP as a framework for planning implementation by suggesting where A-E can best allocate resources within its program and where partnering with other ORD components and other partners outside ORD can support the work at A-E. Finer articulation of those science questions would also help facilitate the re-orientation and selection of science partners for A-E and help shape the various science products needed to meet ORD and A-E objectives and further deliver science to support EPA's missions.
- A-E could improve the StRAP with better developed approaches for distinguishing forest and wildland fire effects from industrial air pollutants and pollutants from other sources. These approaches should support determinations under current EPA regulatory policy related to allowable exceedances under wildfire smoke conditions. Such information would also provide an opening for advancement of source apportionment modeling and the enhanced representation of chemical plume modeling inside large-domain air quality models.

## Recommendations

The subcommittee offers the following recommendations regarding the strategic vision of the program, and the extent to which the StRAP provides a structure for making progress toward outcomes in the 2019–2022 time frame.

**Recommendation 1c.1:** The StRAP should include a description of the process or mechanisms and general timelines that will be used to facilitate access of the A-E partners to data sets, reports, papers, etc., as well as how A-E or ORD will work to translate those science products for broader use in informing decision-making.

*EPA Response: We have added additional text to the Research Topics section that describes the complementary process for developing detailed Research Area plans, which will include a more detailed description of deliverables (outputs and products), timeline and mechanism for delivery, and partner engagement plan that describes how data and reports, etc., can be accessed. In addition, the Air and Energy program is developing a strategic plan for engagement which will set goals for engaging with EPA programs and regions, states, and tribes around science products for broader use in informing decision-making. We will be happy to share a summary of that plan with the BOSC once it has been completed. As a general point, EPA has recently completed its implementation of open data requirements, essentially that all Federally-sponsored (intramural, extramural) publications and supporting data will be made publicly available. https://www.epa.gov/open/plan-increase-access-results-epa-funded-scientific-research*

**Recommendation 1c.2:** The A-E program vision must balance the interests of partners with those of the environmental science research communities to ensure they remain in a leadership role in advancing environmental science. Clearer articulation of the applied science questions that will drive new research for A-E would help refine the research plan and agenda. The present draft StRAP document should include a listing (possibly a table) of research priorities and how they fit into the overall vision of EPA and the StRAP.

*EPA Response: We have added science challenges under each Topic introduction, which indicate the guiding science principles for each topic/research area (see response for recommendation 1c.3 as it is related). We have added a call-out box under in each Research Area to indicate and briefly describe priorities for that RA.*

**Recommendation 1c.3:** A clearer description of specific motivating science questions and why the A-E program is best suited to answer those questions would strengthen the connection of A-E work to the ORD goal of remaining at the forefront of environmental science research. The science challenges outlined early in the plan may be a part of this motivation, but they are organizationally removed from the specific research topics and areas in the StRAP.

*EPA Response: We have added a bulleted list of specific science/research challenges under each topic. Previously these science challenges were listed and described under the program objectives. The revised version puts the challenges in the context of each topic. This revision should make clearer the connection between science challenges and the research conducted in each research area.*

## Charge Question 1d

Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

**Narrative**

The subcommittee recognizes A-E for its proposed work on emerging environmental needs and investments in new research methods as described in the draft StRAP. Air and energy issues range across wide scales in space (e.g., indoor to regional to global air pollution) and time (e.g., acute to chronic health effects), which demand innovative tools and multidisciplinary approaches. The A-E program has proposed a relatively modest (in comparison to past years) but balanced research portfolio with investments in new tools (e.g., low-cost sensors, satellite products) and scientific investigations on criteria pollutants, hazardous air pollutants (HAPs), and emerging issues (e.g., wildland fire impacts).

The subcommittee identified the following strengths of ORD's A-E program to address critical emerging environmental needs, and its investments in staff expertise and research methods, and provides additional suggestions and recommendations for A-E program leadership consideration.

**Strengths**

- The draft A-E StRAP recognizes resource constraints on both intramural and extramural resources from prior years due to staff cuts, loss of critical expertise, and extramural funding reductions, and focuses on what is expected to be doable with anticipated resources.
- The A-E research program successfully balances EPA's responsibilities regarding some legacy areas of scientific investigation (e.g., particulate matter, or PM, health effects, air quality models, cookstove emissions) and critical emerging areas, such as the proposed research on ecosystem and human vulnerability to wildland fires, and wildland fire risk mitigation and communication.
- The bibliography of 878 peer-reviewed publications and other documents published from 2015 to 2018 demonstrates ORD's current success in identifying research priorities and providing important and scientifically relevant outcomes.
- The research program on PFAS demonstrates ORD's multi-disciplinary thinking on emerging environmental topics.
- The draft A-E StRAP material describing the proposed outputs (FY2019–2022) for research on both legacy and emerging areas of investigation was well described and aligned with the identified program, regional, state and/or tribal needs.

**Suggestions**

- The extramural research program (existing STAR and ACE Center grants, Health Effects Institute support) addresses important environmental topics (e.g., health effects from low concentration exposures, cumulative impacts of multiple-pollutants, organic carbon). While a high-level description is provided in the StRAP, an explicit description of how the extramural efforts are complementary with A-E intramural efforts in selected research topics and areas would give a more complete picture of the full research program.
- The A-E StRAP should outline potential issues related to energy in more detail – currently the "E" in A-E is underrepresented. Examples of where proactive research could inform important scientific questions include air quality impacts of distributed generation, impacts of fires and emergency situations at energy storage facilities, potential emissions of chemicals used in carbon capture systems, and end of life issues (e.g., solar panel disposal and potential impacts).
- The A-E StRAP should explicitly include environmental justice topics that are important to Regional, State, Local and Tribal agencies, and the public at large. These can fit into existing efforts on use of low-cost sensors, satellite data, wildland fire impacts, etc.

- There could be more attention to HAPs, especially toxics emitted from brake and tire wear (where ORD can link with European and California efforts), and small stationary facilities (e.g., hexavalent chromium) that have become relatively more important as $PM_{2.5}$- and ozone-related health effects are reduced.
- ORD's indoor air quality program has a long history of advancing knowledge on time-activity patterns and microenvironmental exposures to all age groups, indoor pollutant sources and emissions, radon exposure, exposure reduction strategies, etc. The A-E StRAP has a proper focus on wrapping up ongoing work on cook stoves and new work on indoor penetration of wildland fire smoke, but there could be a stronger effort to rebuild broad staff expertise, seek partnerships with international and other agencies, and link with work on energy systems and environmental justice. For example, building energy efficiency measures have implications for indoor pollutant exposures.
- There could be more attention to simplified tools to assist programs, regional, state, local and tribal agencies with limited resources in addressing their statutory responsibilities. Examples include reduced-form air quality models for State Implementation Plans, simpler tools for source control prioritization (e.g., intake fraction approach, ozone and PM formation scales), identification of long-range transport and global climate impacts on air quality, and identification of super-emitting sources for enforcement purposes.
- The readability of A-E StRAP could be improved with a better mapping of the report's objectives, topics, etc. with a matrix or other type of table or chart. As currently written, the plan identifies four research program objectives, each of which is supported by a number of science challenges. The link between those and the research topics and areas, which appear to be the core of the A-E strategic research plan, needs to be clarified.

## Recommendations

The A-E subcommittee recognizes that ORD is in the midst of what could be a large downsizing in staff and extramural funding, and that its research portfolio over the next three fiscal years should reflect this reduced baseline but still be comprehensive and nimble enough to address the priority research needs of the nation. Until there is more clarity on the resources available through the budget process and implementation of the Administrator's priorities, the subcommittee offers the following recommendations on ORD's A-E program to address critical emerging environmental needs, and its investments in staff expertise and research methods

**Recommendation 1d.1:** Add energy and environmental justice as Cross-cutting Research Issues in Appendix 3.

*EPA Response: Appendix 3 identifies examples of cross-program research issues decided upon corporately across ORD, and the same list appears in each of ORD's research program's StRAPs. While energy and environmental justice are not explicitly identified in these examples, we understand the need to consider how these topics have broad and cross-program relevance and will be important to address throughout the Air and Energy portfolio. We have added text to the StRAP that clarifies where energy and EJ issues will be addressed in the various research areas. Environmental justice is also a major focus of the Sustainable and Healthy Communities (SHC) research portfolio.*

**Recommendation 1d.2:** Consider adding work on HAPs (brake and tire wear, small stationary sources) and simplified tools for SIP modeling, source control prioritization, and enforcement, as resources allow.

*EPA Response: The Air and Energy portfolio includes potential work on emissions from brake and tire wear, as well as emissions and air quality modeling tools for SIP modeling and characterization of emissions changes resulting from source emission controls. We have added text in the Research Areas 1 and 2 sections that highlight some of this proposed research.*

**Recommendation 1d.3:** Consider rebuilding staff expertise on building ventilation and other indoor air quality topics.

*EPA Response: The Air and Energy research portfolio includes proposed outputs addressing indoor air quality resulting from new cookstove technologies, and indoor air quality measurements during wildfire smoke events and their relationship to ambient conditions, building ventilation rates, and air filtration technologies and efficacy. ORD scientists have expertise in indoor air quality, especially related to household energy and heating and measurement of indoor air quality using low cost sensors.*

## Charge Question 1e

> Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

**Narrative**

As stated in the draft StRAP, "the [Clean Air Act] CAA states that EPA shall conduct research "related to the causes, effects (including health and welfare effects), extent, prevention, and control of air pollution." The CAA further requires that this include "research, testing, and development of methods for sampling, measurement, monitoring, analysis, and modeling of air pollutants" and research on "the short-term and long-term effects of air pollutants … on human health." Further research listed under the CAA includes efforts to "improve understanding of the short-term and long-term causes, effects, and trends of ecosystems damage from air pollutants on ecosystems."

The subcommittee applauds the Agency's long history of promoting innovative approaches to solving environmental problems. Historically the Agency used STAR grants to develop mission-oriented scientific projects and issued SBIR awards to encourage scientists, engineers, and entrepreneurs to develop new and potentially marketable environmentally relevant devices and techniques. These programs have been a successful element of EPA's portfolio. While the subcommittee recognizes that A-E does not control the SBIR and the STAR programs, we recommend that A-E grasp any opportunity to use these programs to the extent allowed by available budget. These programs have historically enabled EPA, through its extramural research operation, to work broadly with academia, trade associations and industry to augment its intramural research program. For example, A-E played an integral role in developing the highly successful market-based Acid Rain program.

In addition to capitalizing to the greatest possible extent on the STAR and SBIR programs, we encourage A-E to continue to promote innovations to deal with next generation environmental problems, despite the reduction in staff and financial resources imposed by the "lean" agency profile. EPA can incentivize innovation with efficiency and fiscal responsibility through recognition of exceptionally high-quality research that advances the A-E mission. Criteria for recognition can include individual or team initiative, relevance to the Agency's core mission, responsiveness to state, local, and tribal partner needs, impact

on the state-of-the science/technology, and innovation that leads to cost savings. Awards could involve national recognition for excellence, potentially coupled with monetary awards for exceptional efforts.

The subcommittee suggests that A-E focus available EPA/SBIR resources on specific challenges to develop Next-Gen answers to emerging environmental problems. The Agency should encourage cost sharing. Potential topics might include:

- Air quality impacts on downwind communities and effects on health, which requires research on particle chemistry, exposure scenarios, uptake and distribution in respiratory tracts and translocation to other organs.
- Economic impacts of the effects of pollutants at a range of temporal and spatial scales.
- Fallout of toxic products on soil with subsequent contamination of groundwater; impact on aquatic species. (e.g., GenX in Eastern NC)
- Contamination of agricultural products by toxic fire-related compounds such as polycyclic aromatic hydrocarbons and toxic metals.
- Planning for the future using appropriate climate models to predict number and intensity of wildfires.
- Pesticide use where the product is sprayed as an important exposure route for residents in nearby communities. The crossover is damage to forests by pests leading to increased risk of fires and the risk of bystander exposure. Other air contamination aspects of pesticide usage could be a collaborative effort across EPA divisions and A-E can provide significant expertise related to exposure modeling, exposure assessment, risk assessment and risk management.

The subcommittee also suggests that A-E Environmental Excellence Awards could be established and presented to industry partners and state agencies that demonstrate innovative solutions that reduce emissions, health effects or environmental impacts. Firms could benefit by advertising that they received an EPA award for environmental excellence. This type of incentive worked well with the ENERGY STAR designation program. EPA could also provide testing, certification or validation for innovative measurement instruments or approaches and control technologies. Such an award program could be linked with an SBIR program, which would allow new techniques that solve environmental challenges to be more fully developed and eventually come to market.

A-E could sponsor environmental challenges at relevant national meetings of scientific and trade associations that involve local high school and college teams to compete to solve a local problem selected by the conference organizers with the collaboration of the EPA regional staff. The American Chemical Society and the Air and Waste Management Association both host such annual challenges, which might provide good opportunities for collaboration. The environmental challenges could be cross-cutting across ORD research programs.

The subcommittee suggests that A-E consider developing an EPA Mission Oriented Collaborative Research Program to invite scientists, engineers, stakeholders, tribal and other partners to propose an approach to solve a current or emerging environmental problem. Groups with winning proposals might then work with an A-E team, bringing to bear EPA resources or expertise if specific equipment or methodology were found to be helpful. EPA could also reach out to foundations and form public/private partnerships that could leverage ongoing and new innovative efforts.

EPA could also sponsor partner activities at EPA facilities by expanding a guest researcher and/or intern program, as well as potentially broadening its engagement with other agencies. Ideas include:

- Inviting candidates who propose an innovative solution to a current or emerging environmental problem to work with A-E scientists to test a new approach or device where access to EPA resources and facilities could accelerate progress.
- Facilitating the testing of developed instruments, procedures and technologies at EPA or in the field at partner's facilities.
- Augmenting resources by reaching out to foundations and making use of expertise at other agencies (e.g. National Air and Space Administration [NASA], U.S Department of Energy [DOE]) that have environmental mandates to expand specific programs.
- Partnering with other agencies on key research agendas and topics, maximizing efficiencies and making the best use of intellectual and physical capital. As just one example the U.S. National Climate Assessment, a multi-agency report released late in 2018, recommends five foundational cross-cutting research areas, the first two of which (integrated natural and social science, engineering and other approaches; and observations, monitoring and infrastructure for critical data collection and analysis) are well suited for A-E to address in partnership with others.

The subcommittee would like to emphasize the importance of improving and applying EPA's AERMOD, Community Multiscale Air Quality Modeling System (CMAQ), and Benefits Mapping and Analysis Program (BenMAP) software for the purpose of accurately monetizing the cost of airborne pollutant emissions, as a first step in developing market-based incentives for mitigating current or emerging environmental issues. Reasons include:

- Market-based incentives (MBIs) could be useful and cost-effective alternatives to imposing new regulations for pollution control.
- Environmental taxes, deposit refund systems, and tradeable pollution permits could be suitable instruments for inducing pollution abatement behavior.
- A key barrier to employing MBIs to promote pollution abatement is developing a realistic dollar value to be applied to the value of a tax or credit, which could be addressed and verified by the application of appropriate EPA computational models.
- Updates and modifications of EPA's computational arsenal could support the development by EPA, state and tribal partners of pollutant trading or subsidy strategies or approaches as alternatives to new regulatory actions.

## Recommendations

The subcommittee offers the following recommendations regarding ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems.

**Recommendation 1e.1:** While the subcommittee recognizes that A-E does not control the EPA/SBIR program, A-E should grasp any opportunity to use the SBIR program to develop Next-Gen answers to emerging environmental problems. Potential topics are listed in the text.

*EPA Response: ORD agrees that the SBIR program provides excellent opportunities to address emerging environmental problems. ORD recently awarded an SBIR contract "to reduce emissions of methane and volatile organic compounds (VOCs) by developing a combined capture technology that can be used at well sites, natural gas facilities, storage sites, and transmission facilities." (see https://www.epa.gov/newsreleases/epa-awards-27-million-small-businesses-commercialize-environmental-technologies). The Air and Energy program will continue to encourage small businesses to take advantage of these opportunities offered through the annual SBIR solicitations. We have added text noting our support for the SBIR program in the Program Design section. In addition, during the ORD reorganization, a number of research support functions were incorporated into the new Partnerships Branch of the Office of the Science Advisor, Policy, and Engagement (OSAPE), with the objective of better strategic alignment and coordination of various resource opportunities to support research, including working with the SBIR program. OSAPE also houses the EPA research grants staff, who manage the Science to Achieve Results (STAR) grants program, which has proven very successful in eliciting innovative input from the academic/non-profit community to address emerging environmental problems.*

**Recommendation 1e.2:** While the subcommittee recognizes that A-E does not control the STAR program, A-E should take advantage of any access to the STAR program to provide specific challenges to scientists and engineers to identify an emerging environmental problem and submit a concept proposal for addressing that concern. The A-E program could encourage cost sharing and provide funding and/or other resources to one or more concepts that would advance the strategic priorities of the program.

*EPA Response: We have added text in the Program Design section that emphasizes how the STAR program can be used to address emerging environmental problems. One example of this collaborative process for innovation has been with the motor vehicle industry through the Health Effects Institute (HEI), where EPA has awarded grant funding to HEI to support innovative research to improve air quality.*

**Recommendation 1e.3:** Establish an Interagency Task Force to focus on future needs and to make available or share resources. In the lean agency framework, the utilization of existing equipment and facilities that are underused could be maximized through intra-agency, interagency and collaborative research initiatives. An active program of collaboration and cooperation should be fostered to maximize efficiency and make the best use of intellectual and physical capital.

*EPA Response: ORD is addressing these concepts of future needs and optimizing resource utilization at a broad variety of levels, through interagency engagements, ORD's newly-designated leadership as National Program Manager for Regional Laboratories, and public-private arrangements. Air and Energy researchers actively participate in several existing interagency coordination bodies, from the legislatively-mandated US Global Change Research Program (USGCRP) and Strategic Environmental Research and Development Program (SERDP) to the informal Air Quality Research Seminars and Discussion Group, that identify and facilitate interagency coordination and collaboration. In addition, ORD has established interagency agreements and/or memoranda of understanding with NASA, NIH, USDA, NOAA, NPS, and others to support research on health, air quality, and atmospheric deposition. ORD works closely with USFS, CDC, NOAA, NASA, and other federal agencies to address scientific needs related to wildfire smoke and use of satellite data to characterize emissions and air quality.*

## Summary List of Recommendations

This section provides a listing in a single location of the recommendations provided earlier in the report in response to each charge question.

### Charge Question 1a. Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

- **Recommendation 1a.1:** Identify and describe in the StRAP the process by which A-E will balance immediate needs within EPA and longer-term, exploratory research objectives so that A-E and ORD can be prepared for future science needs. The action plan should include a process for review and evaluation of this balanced approach.
- **Recommendation 1a.2:** Add discussion in the StRAP to reflect activities by A-E (current and planned) concerning EPA Strategic Plan Objective 3.5 "Improve Efficiency and Effectiveness", and ORD Goal 3: Enhancing the Workforce and Workplace.

### Charge Question 1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

- **Recommendation 1b.1:** There is a need to have more engagement with states and tribes, in particular, educational outreach on A-E capabilities. It would also be helpful to educate partners on the kinds of questions EPA can answer. For example, EPA staff might attend MJO meetings (in person or via webinar) to present ORD capabilities and then ask questions of states' needs. This can be a good mechanism for identifying emerging issues.
- **Recommendation 1b.2:** Academia, science associations etc. are mentioned in the draft StRAP, but it would be helpful to discuss in more detail how these outreach efforts occur and are utilized by EPA. NGOs are not discussed and should be included (unless they are considered community action groups).
- **Recommendation 1b.3:** We encourage continued collaboration and communication through sensor workshops/wildfire workshops and including communities involved in these issues to be a part of the workshops.

### Charge Question 1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

- **Recommendation 1c.1:** The StRAP should include a description of the process or mechanisms and general timelines that will be used to facilitate access of the A-E partners to data sets, reports, papers, etc., as well as how A-E or ORD will work to translate those science products for broader use in informing decision-making.
- **Recommendation 1c.2:** The A-E program vision must balance the interests of partners with those of the environmental science research communities to ensure they remain in a leadership role in advancing environmental science. Clearer articulation of the applied science questions that will drive new research for A-E would help refine the research plan and agenda. The present draft

StRAP document should include a listing (possibly a table) of research priorities and how they fit into the overall vision of EPA and the StRAP.

- **Recommendation 1c.3:** A clearer description of specific motivating science questions and why the A-E program is best suited to answer those questions would strengthen the connection of A-E work to the ORD goal of remaining at the forefront of environmental science research. The science challenges outlined early in the plan may be a part of this motivation, but they are organizationally removed from the specific research topics and areas in the StRAP.

Charge Question 1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

- **Recommendation 1d.1:** Add energy and environmental justice as Cross-cutting Research Issues in Appendix 3.
- **Recommendation 1d.2:** Consider adding work on HAPs (brake and tire wear, small stationary sources) and simplified tools for SIP modeling, source control prioritization, and enforcement, as resources allow.
- **Recommendation 1d.3:** Consider rebuilding staff expertise on building ventilation and other indoor air quality topics.

Charge Question 1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

- **Recommendation 1e.1:** While the subcommittee recognizes that A-E does not control the EPA/SBIR program, A-E should grasp any opportunity to use the SBIR program to develop Next-Gen answers to emerging environmental problems. Potential topics are listed in the text.
- **Recommendation 1e.2:** While the subcommittee recognizes that A-E does not control the STAR program, A-E should take advantage of any access to the STAR program to provide specific challenges to scientists and engineers to identify an emerging environmental problem and submit a concept proposal for addressing that concern. The A-E program could encourage cost sharing and provide funding and/or other resources to one or more concepts that would advance the strategic priorities of the program.
- **Recommendation 1e.3:** Establish an Interagency Task Force to focus on future needs and to make available or share resources. In the lean agency framework, the utilization of existing equipment and facilities that are underused could be maximized through intra-agency, interagency and collaborative research initiatives. An active program of collaboration and cooperation should be fostered to maximize efficiency and make the best use of intellectual and physical capital.

## CONCLUSIONS

Overall, the A-E subcommittee found that the draft A-E StRAP clearly describes a strategic vision and action plan that supports the Agency priorities and Strategic Plans. The A-E research program focuses on the science and engineering approaches needed to improve air quality, reduce the number of nonattainment areas in the United States, and protect public health and the environment. The draft StRAP effectively links A-E research priorities with the appropriate regulatory drivers and policy context for the

agency, and lays out a research agenda that balances the needs of stakeholders and partners with important and emerging topics in environmental science. The plan could do more to highlight the overall integrated research portfolio with some description of extramural research efforts, particularly as complementary with A-E intramural efforts around key strategic topics; this would give a more comprehensive view of the full research program. The subcommittee also encourages A-E to place a priority on ensuring the portfolio effectively balances near-term needs within the agency with longer-term, exploratory research objectives. Striking the proper balance of work for immediate agency responses and a commitment to longer-term research on topics relevant to A-E missions and goals will help ensure that A-E and ORD as a whole can continue leading advancements in environmental science.

The new structure for the A-E research program, around three science topics and one integrated topic, provides a useful construct for the future directions of the program. Each of the three topics and related research areas are well suited to the program's strengths, while also supporting opportunities to address complex and/or emerging scientific issues with a systems approach. The plan successfully balances EPA's responsibilities regarding historical areas of scientific investigation (i.e., air quality models) with critical emerging areas. The selection of wildfires research as a cross-cutting topic, as an example, addresses an important science gap, leveraging the strengths of the A-E team. Providing opportunities in the plan for emerging, cross-cutting areas is important, as the increasing complexity of environmental issues will continue to require integration across more traditional research topics. The plan would benefit from a clearer articulation of the applied science questions that will drive the research agenda, aligning these questions more clearly with the specific research topics and areas in the StRAP. The links between the program objectives, science challenges, research topics and research areas are not as clear as they could be. The subcommittee also suggests that the plan should outline potential issues related to energy in more detail – the "E" in A-E is currently underrepresented. The StRAP could also be improved with a greater articulation of expected outcomes related to the research in support of EPA/ORD strategic priorities and objectives.

The presentations and discussion at the review meeting demonstrated the extent of the outreach and engagement by the A-E team with partners and stakeholders, though not all of these efforts are reflected in the draft StRAP. The document could do more to clearly convey the breadth of engagement as well as the commitment to continued dialogue and interaction. There are a number of specific recommendations in the report that discuss areas where additional clarity would be useful. The subcommittee also notes that it is important for the program to retain a balance between partner-driven research priorities and those required to ensure that the A-E team maintains its leadership role in the science community and continues to fulfill its mission. To that end, we encourage the A-E program to ensure that scope is maintained for exploratory research that allows the agency to respond to emerging issues.

The subcommittee encourages A-E to continue to pursue innovative approaches to conducting their research and to rewarding/encouraging their scientists. This is particularly important given the recent reductions in staff and financial resources. A number of ideas are provided for consideration by the A-E program, including awards and recognition of excellence both for program scientists who have achieved exceptionally noteworthy research or technology outcomes and for industry partners and/or state agencies that demonstrate innovation solutions. The subcommittee reinforced the value of the EPA SBIR and STAR programs, and encourages the agency to reinvigorate those programs, perhaps with a specific focus on emerging environmental challenges or focused topical areas of research.

In conclusion, the subcommittee believes that the A-E StRAP articulates and organizes an ambitious and achievable research program that is well-aligned with EPA's objectives and mandates to improve air quality, reduce the number of nonattainment areas in the United States, and protect public health and

the environment. The A-E StRAP will promote high priority research needed by EPA's partners with the resources available. The subcommittee looks forward to reviewing the implementation of the research outlined in this StRAP in future meetings, and continuing to serve as a resource to the A-E program on scientific and strategic topics related to its research programs.

# APPENDIX A: MEETING AGENDA

**United States Environmental Protection Agency**
**Board of Scientific Counselors (BOSC)**
**Air and Energy (A-E) Subcommittee**

Meeting Agenda – November 13-14, 2018
Research Triangle Park, North Carolina
Room C112

| TIME | TOPIC | PRESENTER |
|---|---|---|
| **Tuesday, November 13, 2018** | | |
| 8:00-8:30 | Registration | |
| 8:30-8:40 | Welcome, and Opening Remarks Introduction | Charlette Geffen, Chair |
| 8:40-9:00 | Subcommittee Introductions | Subcommittee |
| 9:00-9:10 | DFO Welcome | Tim Benner |
| 9:10-9:30 | ORD Welcome | Jennifer Orme-Zavaleta |
| 9:30-11:30 | StRAP Development Presentation<br>• General approach<br>• Expanded engagement with stakeholders<br>• Proposed A-E program structure moving forward<br>• Time allowed for SC questions | Alan Vette |
| 11:30-11:45 | Review of Charge Questions | Charlette Geffen, Chair |
| 11:45-1:00 | Lunch | |
| 1:00-1:30 | Public comments (if any) | |
| 1:30-3:30 | Discussion of Charge Questions<br>• EPA Overview<br>• SC Discussion | Alan Vette<br>Subcommittee |
| 3:30-4:30 | Subcommittee Discussion and EPA response to questions | Subcommittee<br>Alan Vette |
| 4:30-4:45 | Wrap-up and Adjourn | |
| **Wednesday November 14, 2018** | | |
| 8:30-9:30 | Subcommittee discussion<br>EPA response to Subcommittee questions | Subcommittee<br>Alan Vette |
| 9:30-12:00 | Subcommittee discussion and writing | Subcommittee |
| 12:00-12:45 | Lunch | |
| 12:45–2:15 | Subcommittee discussion and writing | Subcommittee |
| 2:15-2:30 | Wrap-up and Adjourn | |

Note: The agenda does not include specific breaks. The SC can take those as needed.

# APPENDIX B: MATERIALS

## Material Provided in Advance of the Meeting

***Materials to Support the Charge Questions***

- Agenda
- Charge questions
- Draft StRAP (External Review Draft, October 24, 2018 version)
- EPA Strategic Plan https://www.epa.gov/planandbudget/strategicplan
- ORD Strategic Plan
- A-E Program Summary
- Partner Engagement Summary

***Informational Materials***

- Product and output summaries (7 examples provided; additional examples can be made available if these are useful)
- Bibliography (2015-2018)
- A-E Resources sheet with links to:
    - ACE/A-E External Newsletter
    - FACT Sheets; can provide
    - Science matters
    - Grants information
    - Tools and toolboxes

## Additional Material Provided During the Meeting

- National Tribal Association's Status of Tribal Air Report, May 2018, presented at the National Tribal Forum on Air Quality Hosted by the Fond Du Lac Band of Lake Superior Chippewa.
- Interstate Technology and Regulatory Council (ITRC), 2018 Priorities with Focused Constraints – States Point to Shifting Product Needs (summary of state priorities from 2018 survey of states to understand the environmental issues and the technical constraints preventing solution).
- Environmental Research Institute of the States (ERIS), 2016 ERIS States' Research Needs Survey, A Summary of State Environmental Priorities.
- U.S. Environmental Protection Agency (EPA), Office of Research and Development (ORD), PowerPoint presentation by Alan Vette, Acting Program Director of the Air and Energy Research Program: Air and Energy National Research Program, Discussion with A-E BOSC Subcommittee on the Draft A-E Strategic Research Action Plan (StRAP).

BOSC
BOARD OF SCIENTIFIC COUNSELORS

# REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

## BOSC CHEMICAL SAFETY FOR SUSTAINABILITY/HUMAN HEALTH RISK ASSESSMENT SUBCOMMITTEE


| | | |
|---|---|---|
| Katrina Waters, Ph.D. (Chair)<br>*Pacific Northwest National Laboratory* | Chris Gennings, Ph.D.<br>*Icahn School of Medicine at Mount Sinai* | Jane Rose, Ph.D.<br>*Procter & Gamble Co.* |
| James Stevens, Ph.D. (Vice Chair)<br>*Paradox Found LLC* | Dale Johnson, Pharm.D., Ph.D., DABT<br>*University of California, Berkeley; University of Michigan; Emiliem Inc.* | Gina Solomon, M.D., MPH<br>*Public Health Institute; University of California, San Francisco* |
| Anthony Bahinski, Ph.D., MBA, FAHA<br>*GlaxoSmithKline* | Daland Juberg, Ph.D., ATS<br>*Juberg Toxicology Consulting LLC* | Ponisseril Somasundaran, Ph.D., MS<br>*Columbia University; Somasundaran Inc.* |
| Richard Becker, Ph.D., DABT<br>*American Chemistry Council* | Juleen Lam, Ph.D., MHS, MS<br>*California State University, East Bay* | Donna Vorhees, Sc.D.<br>*Health Effects Institute; Boston University* |
| Juan Colberg, Ph.D.<br>*Pfizer Inc. Worldwide Research and Development* | Timothy Malloy, J.D.<br>*University of California, Los Angeles* | Clifford Weisel, Ph.D.<br>*Rutgers University* |
| Richard Di Giulio, Ph.D., MS<br>*Duke University* | Jennifer McPartland, Ph.D.<br>*Environmental Defense Fund* | Mark Wiesner, Ph.D.<br>*Duke University* |


EPA Contact
**Tom Tracy, Designated Federal Officer**

August 19, 2019

# CONTENTS

**INTRODUCTION** ..... **B-5**

**BACKGROUND** ..... **B-5**

**STRAP RESEARCH OBJECTIVES** ..... **B-6**

**CHARGE QUESTIONS AND CONTEXT** ..... **B-6**

**SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS** ..... **B-7**
Charge Question 1a ..... B-8
Charge Question 1b ..... B-11
Charge Question 1c ..... B-16
Charge Question 1d ..... B-19
Charge Question 1e ..... B-21

**SUMMARY LIST OF RECOMMENDATIONS** ..... **B-24**

**CONCLUSIONS** ..... **B-26**

**APPENDIX A: MEETING AGENDA** ..... **B-27**

**APPENDIX B: MATERIALS** ..... **B-30**
Material Provided in Advance of the Meeting ..... B-30
Additional Material Provided During the Meeting ..... B-30

## LIST OF ACRONYMS

| | |
|---|---|
| AOP | Adverse Outcome Pathways |
| BOSC | Board of Scientific Counselors |
| CHEAR | Child Health Exposure Assessment Resource |
| CompTox | Computational Toxicology |
| CSA | Chemical Safety Analytics |
| CSS | Chemical Safety for Sustainability |
| DMSO | Dimethyl sulfoxide |
| ECOS | Environmental Council of the States |
| EPA | U.S. Environmental Protection Agency |
| FDA | U.S. Food and Drug Administration |
| FY | Fiscal year |
| HHRA | Human Health Risk Assessment |
| HTS | High-throughput screening |
| ISI | Influential Science Information |
| IVIVE | In vitro/in vivo extrapolation |
| LCA | Life Cycle Assessment |
| NAMs | New approach methodologies |
| NGO | Non-governmental organization |
| NHANES | National Health and Nutrition Examination Survey |
| NIEHS | National Institute of Environmental Health Sciences |
| NTP | National Toxicology Program |
| OCSPP | EPA's Office of Chemical Safety and Pollution Prevention |
| OLEM | EPA's Office of Land and Emergency Management |
| OPP | EPA's Office of Pesticide Programs |
| OPPT | EPA's Office of Pollution Prevention and Toxics |
| ORD | EPA's Office of Research and Development |
| OSCP | EPA's Office of Science Coordination and Policy |
| OW | EPA's Office of Water |
| PFAS | Per- and polyfluoroalkyl substances |
| POD | Point of departure |
| RARE | EPA's Regional Applied Research Effort |
| REMD | Rapid Exposure Modeling and Dosimetry |
| SOT | Society of Toxicology |
| STAR | Science to Achieve Results |
| StRAP | Strategic Research Action Plan |
| TSCA | Toxic Substances Control Act |
| UVCB | Unknown or variable composition, complex reaction products, and biological materials |

## INTRODUCTION

The mission of the U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) is to provide the best available science and technology to inform and support public health environmental decision-making at the federal, state, tribal, and local levels, addressing critical environmental challenges and anticipating future needs through leading-edge research. ORD prepares Strategic Research Action Plans (StRAPs) to guide its research planning over the ensuing four years, and beyond. EPA plays a central role in evaluating potential impacts of chemicals on human health and the environment. EPA's objectives are to provide efficient, transparent, and scientifically robust approaches to evaluating chemical safety and to continually improve these approaches in response to scientific and technological advancements. To achieve this, EPA applies advanced toxicological and exposure methods, data, tools, models, and information access to make better informed and more timely decisions about the safety of chemicals, many of which have not been thoroughly evaluated for potential risks to human health and the environment. EPA's Chemical Safety for Sustainability (CSS) national research program is designed to support EPA's priority of reducing risks associated with exposure to chemicals in commerce, consumer products, food, and the environment.

## BACKGROUND

The draft 2019–2022 StRAPs are the third such Strategic Planning exercise in this format (previous StRAPs covered 2012–2016 and 2016–2019). The draft 2019–2022 StRAPs orient ORD's research to respond to Administration priorities, as expressed in EPA's Strategic Plan. Additional detail on specific research needs has been identified through formal discussions with EPA programs and regions over calendar year 2018. Development of this third iteration of the StRAPs also emphasizes consultation with the states to identify their needs, particularly through the Environmental Council of the States (ECOS), along with engagement with the tribes. In developing the StRAP, CSS reaches out to both EPA partner organizations (partners) and external stakeholders (stakeholders) as defined in the StRAP.

ORD developed this Chemical Safety for Sustainability Strategic Research Action Plan 2019–2022 (CSS StRAP) to articulate the chemical safety research needs of ORD's partners, outline strategic outputs to address those needs, and guide development of research implementation plans. ORD sought input from the Board of Scientific Counselors (BOSC) CSS and Human Health Risk Assessment (HHRA) subcommittee on the draft StRAP document and proposed research strategies therein. The emphasis of the review was on advancing ORD research to successfully address the needs identified by EPA programs and regions, and states and tribes. This BOSC review covered only the Strategic Planning phase and will be followed by regular BOSC reviews of research activities over the course of StRAP implementation.

The CSS national research program is transforming chemical risk-based decisions by conducting high-quality, innovative scientific research to support the Agency, states, tribes, and other stakeholders in fulfilling their shared objectives to protect human health and the environment. CSS has a history of conducting innovative science and is a hub of global scientific expertise and leadership in many areas, such as computational toxicology, high-throughput toxicology, rapid exposure science, and complex systems science.

## STRAP RESEARCH OBJECTIVES

The 2019–2022 CSS StRAP was developed through multiple interactions, meetings, workshops, and consultations between ORD scientists, EPA partners, and external stakeholders. The overarching goal of the CSS program to provide the scientific foundation required for risk assessments that help inform decisions about the use of chemicals that protects human health and the environment. This has been and continues to be focused on the following objectives and outputs: creating, enhancing, and maintaining a robust chemical safety informatics infrastructure to support decision makers at all levels; creating relevant data via high throughput hazard and exposure methodology to fill data gaps that would otherwise make decisions more difficult; incorporating and establishing a complex systems science approach to enhance interpretations and decision-making at all levels of data development and usage; approaches to extrapolate and extend the applicability of multiple sources and types of data among chemicals, between species, at different life stages, and biological levels of organization such as organelle, cells, tissues, organs, organ systems, organisms, populations, communities, ecosystems, and the biosphere; and the enhancement of chemical safety evaluations to include consideration of sensitive populations and life stages. During the 2019–2022 time frame, CSS will concentrate on the development, demonstration, delivery, and application of CSS data, tools, models, and the informatics infrastructure through partner and stakeholder engagement to meet both immediate and high-priority needs.

The CSS research plan is guided by four program objectives, three research topics, eight research areas, and 48 defined strategic outputs.

## CHARGE QUESTIONS AND CONTEXT

The CSS and HHRA BOSC subcommittee was charged with five questions as follows:

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?
>
> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?
>
> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.
>
> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any *other critical emerging* environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?
>
> Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

## SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Investments made throughout the last 10–year period are coming to fruition, and current efforts demonstrate vision for what is needed in the future. The forward-looking efforts of CSS are to be commended and supported. ORD is well positioned to assist EPA programs with their research initiatives, especially those that fall across multiple programs. The subcommittee was impressed with the clarity and coherence of the strategic vision of the program. The research as outlined and the proposed outputs in the CSS StRAP 2019–2022 clearly define the desired research vision of the CSS program.

Based on the draft CSS StRAP document, presentations, posters, and demonstrations, the research areas and proposed outputs appear to align well with the vision of the program. While the CSS strategic outputs appear relevant to the CSS vision, specific research activities are not yet articulated so it is difficult to determine if they will meet their objectives. The subcommittee anticipates that CSS will clearly articulate the research activities that will be undertaken in its StRAP during the next review meeting so that the linkage between execution and output can be seen.

One particular missing feature of the vision was highlighted repeatedly regarding the importance of prioritizing and continuing research on chemical mixtures in both CSS and HHRA subcommittee discussions. Such research is critical to assessing real-world impacts of chemical exposures. The committee recommends that mixtures research and work on cumulative risk assessment be an explicit component of both research programs. For example, high-throughput testing should include mixtures of chemicals identified from biomonitoring studies, and other health- and ecologically-relevant mixtures.

The outreach efforts to EPA partners and external stakeholders could also be more fully described. In the meeting discussion, it became clear that the CSS program had conducted more outreach than was described in the StRAP and appendices. While Appendices 1, 2, and 3 document important steps taken to ascertain research needs of CSS' EPA partners, several important aspects of the engagement process and its outcome remain opaque in the StRAP. For example, the StRAP lacks discussion of how EPA regional partner needs were identified beyond the fact that meetings, workshops, and collaborations occurred. How were partner representatives identified and recruited to ensure that relevant voices were heard? Were research needs solicited from all EPA program offices and regions, states, and tribes? How exactly were research needs elicited? For example, it is not entirely clear whether the three meetings with tribes (Appendix 2) provided tribes an opportunity to identify research needs in addition to hearing CSS summarize progress being made on the development of the StRAP. And, finally, what criteria did CSS use to classify research needs as "highest priority"?

In addition, the potential for partnership between the CSS program and HHRA program would seem to be especially valuable for increasing use of new approach methodologies (NAMs) in risk assessment. However, the description of the RapidTox project was the only to mention collaboration with HHRA specifically. This would seem to represent a missed opportunity for important stakeholder engagement. HHRA serves an important partner for evaluating, piloting, and advancing the use of NAMs in risk assessment and translating such learnings and experience to risk assessment practitioners. CSS should include HHRA in its partner outreach efforts to identify opportunities for advancing the use of NAMs in risk assessment and to identify gaps in the data available for current risk assessments that might be informed by NAMs. Similarly, engagement of other important federal partnerships, such as the National Toxicology Program (NTP) and Tox21 Consortia were not described.

Given the mandated focus of Toxic Substances Control Act (TSCA) to consider chemical exposures to susceptible subpopulations, it was surprising to hear little mention of research priorities related to the

individuals which may be at greater risk than the general population of adverse health effects from exposure to a chemical substance or mixture, such as infants, children, pregnant women, workers, or the elderly.

Specific areas of strength as well as suggestions for the CSS StRAP are described below.

## Charge Question 1a

> Q.1a. Does the research outlined for the 2019-2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

**Narrative**

The EPA Strategic Plan has shifted toward three central goals: "Core Mission, Cooperative Federalism, and Rule of Law and Process." Specifically, EPA plans to: "(1) refocus the agency back to its core mission of protecting human health and the environment; (2) restore power to the states through cooperative federalism; and (3) lead the agency through improved processes and adhere to the rule of law." In addition, the safety of chemicals in the marketplace is prioritized as part of the implementation of the Frank R. Lautenberg Chemical Safety for the 21st Century Act.

ORD's overarching strategic metric is stated in its 2019–2022 Strategic Plan as: "By September 30, 2022, ORD will increase the number of research products meeting customer needs." ORD also lays out three Goals that parallel Agency goals in its Strategic Plan:

> Goal 1: Enhancing Environmental Science and Technology: ORD will work with its partners to identify high priority research needs and develop the research tools necessary to inform environmental decision-making at the local, state, regional, national and international level. ORD will refine its research efforts and finalize the 2019–2022 StRAPs based on feedback from decision-makers.
>
> Goal 2: Cooperative Federalism: Informing Federal, State, Tribal and Local Environmental Decision-making: an overarching approach to strengthen relationships with states has been adopted, outlining engagement activities and opportunities to inform decision-making.
>
> Goal 3: Enhancing and Sustaining a Strong ORD Workforce and Workplace: an ORD Workforce Strategy has been developed.

One of the EPA Strategic Plan goals is to "ensure compliance with the law by providing consistency and certainty for the regulated community and clarify the impact of proposed actions on human health, the environment and the economy to provide a clear path and timeline for entities to achieve compliance." The CSS StRAP outlines the program's general approaches to identifying the needs of its partners and stakeholders, and to developing NAMs and robust informatics infrastructure to fulfill research and data needs in toxicology and exposure toward protecting human health and the environment. The StRAP outlines research goals to advance and incorporate cutting edge science in areas including NAMs, emerging materials and technologies and virtual tissue modeling. However, there are concerns from a reduced emphasis in the StRAP on sustainability that could reduce the ability to identify safer chemical alternatives and a lack of emphasis on chemical mixtures. These are weaknesses that will reduce CSS's ability to support its partners and stakeholders to address important environmental contaminants and protect public health.

**Strengths**

- The state-of-the-art science being conducted to understand exposures and toxicological effects to humans and ecosystems provides the necessary underpinnings to meet the core EPA mission of providing clean air, land, and water, and ensuring chemical safety. These include their developing strengths in NAMs and virtual tissue modeling which can provide leadership in moving towards using in-vitro testing to support risk analysis.
- Interactions with EPA program and regional offices enable them to carry out their missions when issues related to contaminants in the environment arise. Approaches to understand what its partners and stakeholders need have improved, though challenges still exist as addressed elsewhere in the review.
- There is strong vision and breadth in pulling together informatics, methods and analytical tools to create an integrated system for use in prediction and screening for chemical evaluation. These have continually expanded, and CSS development of new tools and methodologies are highly relevant, and are being applied to meet Agency priorities as identified by program offices that presented to the subcommittee. The training interaction that CSS can provide in use of these tools is a strength and should be continued as is the wealth of information being incorporated in the data bases.
- Strategic outputs described for the research areas have incorporated more agency mission products than in previous years, documenting the greater role the CSS has had in supporting the Agency's mission.
- The subcommittee commends the research effort focused on chemicals that are difficult to test (e.g., volatile or insoluble in dimethyl sulfoxide, or DMSO), as these chemicals could otherwise be unaddressed by the emerging testing methods.
- CSS has developed expertise in multiple scientific research areas to evaluate physical, chemical and biological transformation of chemicals in the environment and endogenous metabolism that can contribute to addressing uncertainties in estimating or predicting exposure and dosimetry. The continued building and implementing of CSS capability in state of the art scientific laboratory and modeling capabilities are a strength that are providing the necessary tool to address emerging issues now and will be important for the future and currently unrealized environmental issues arise in the future.

**Suggestions**

- The renaming of Sustainable Chemistry research area to Chemical Safety Analytics (CSA) reflects a reduced emphasis on sustainable chemistry." Although, the change addresses the high-priority need for better toxicity assessment methods, it sacrifices another aspect that is important for the regulated community, which is identification of safer chemical alternatives. Although efforts to identify safer alternatives could be achieved via collaborations between the private and academic sector, ORD is in the unique position to drive the research needed to identify safer chemicals. This could be achieved with a minimum ORD budget/resources commitment by collaborating with a scientific consortium, something that has been used globally.
- The EPA and ORD priorities include a broader focus than the current principal focus of CSS. It appears that the CSS is currently focused on producing tools for the TSCA program and the pesticide program. These are both important, but given the EPA and ORD priority of cooperative federalism, it is important for CSS not to lose sight of important priorities associated with the regions and states, as well as with other program offices at EPA, most notably EPA's Office of Land and Emergency Management (OLEM). These entities are often dealing with complex mixtures of

chemicals in the environment, degradation products of chemicals, and chemicals that may not be currently manufactured, but have been released to the environment. The subcommittee did not see much as much effort as may be warranted in these important areas.

## Recommendations

The subcommittee offers the following recommendations to capitalize on further align the StRAP with the EPA and ORD Strategic Plans:

**Recommendation 1a.1:** We recommend that the effort to include early stage life-cycle analysis (LCA) as a decision-making tool along with on-going work should not be de-emphasized as it would appear to be both needed and cost effective. A de-emphasis on early stage LCA and sustainable chemistry may impact the ability to evaluate emerging chemicals and materials, and to compare alternatives. However, the current research effort is developing many of the elements of early stage LCA, including chemical screening and ecosystem impact tools.

*EPA Response: We agree that LCA is a valuable approach to evaluate the potential environmental impacts of a chemical or product. Feedback from EPA program offices emphasized that their interest in LCA-type considerations generally begins with the "as submitted" product. Thus, early aspects of the life-cycle that precede submission, such as material acquisition, energy consumption, and aspects of manufacturing, typically fall outside of their scope of interest and/or authority. On the other hand, the LCA components informing worker exposure, product use, disposition (decomposition, component releases), recycling, and disposal are of priority to them. ORD maintains and uses LCA expertise under the SHC National Research Program to evaluate environmental burdens associated with the life cycles of materials and services, from cradle-to-grave, and closely related to the needs of EPA's Office of Land and Emergency Management (OLEM). CSS coordinates with SHC on chemical LCA concerns of interest to OLEM.*

**Recommendation 1a.2:** Toxicological evaluation of chemical mixtures, based on common chemical co-exposure, should have a higher priority. This should augment the current focus on individual chemical species or chemical groups so that future efforts include exposures and use of materials that include complex mixtures of chemicals. The StRAP should present better articulation and inclusion of mixtures in case studies and strategic outputs.

*EPA Response: We agree that evaluation of chemical mixtures is important. Most of the language in the StRAP centers on the concept of single chemical evaluations because it is the predominant framework in use by our EPA program offices. For challenging emerging needs such as the family of PFAS chemicals, we also recognize that initial single chemical evaluations to ascertain toxicity-profile groups will inevitably lead to mixture analyses. At present, there are a substantial number of CSS research activities that are designed specifically to address mixtures, including:*

- *Field-based case studies in the Great Lakes, California, and other locations that, by definition, have been evaluating mixtures in surface waters;*
- *Complex mixture samples from environmental media have been evaluated through a subset of ToxCast assays;*
- *ToxCast data have been used to evaluate chemical mixtures detected in environmental media;*
- *Non-Targeted Analysis applications are being developed and used to better define complex mixtures in a variety of media;*
- *The UVCB work will address mixtures, at least in the source compound, although how these compounds behave in environmental media may be complicated;*

- *AOP work includes evaluation of mixtures based on common molecular initiating events of chemical groups and of AOP networks that essentially link across MIEs that could be impacted through mixture exposures.*

## Charge Question 1b

Q.1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

**Narrative**

CSS has made a considerable effort to identify needs of program offices, regional offices, states, and tribes and develop tools that are readily available for use, along with CSS personnel availability to help partners and stakeholders with their use. That said, there are challenges with the interaction with the states and tribal groups due to the large range of needs and scientific expertise among those entities, and the StRAP did not reflect as much outreach to some entities as others. For example, a survey through ECOS is not necessarily likely to surface the many ways that CSS products could help states to carry out their work. The StRAP document and presentation outlines some of the approaches being used. CSS has made strides in developing and making available tools that facilitate the Agency in addressing core goals.

In the draft StRAP, CSS explains that a plan was developed to elicit the research needs of its partners, directly following from goals outlined in EPA's overarching Strategic Plan, and to outline a plan for meeting those needs. As defined in the StRAP, CSS's partners are EPA program and regional offices, states, and tribes (including organizations and subsidiaries thereof), although CSS National Program Director, Dr. Jeff Frithsen, explained to the subcommittee that the needs of EPA program offices and regions take priority in defining CSS research.

Since mid-2017, CSS has worked to identify the research needs of its partners by "conducting topical workshops, briefing partners on CSS StRAP development, conducting regularly scheduled consultations, collaborating with partners on programmatic strategies and plans, and providing opportunities for partners to review the CSS StRAP at different stages of development." Appendix 1, "Partner and stakeholder needs and CSS strategic outputs" summarizes the "highest priority needs" of all partners, while Appendix 2, "Partner and stakeholder engagements to inform the CSS StRAP development" and Appendix 3, "State needs as conveyed to EPA by the Environmental Council of States (ECOS)," are meant to capture various interactions and solicitations used by ORD to identify partner needs.

**Strengths**

- The StRAP provides evidence that CSS sought to identify and prioritize the research needs of its partners. They did so through an extensive series of workshops, meetings, and other formal and informal collaborations. Importantly, the proposed research outlined in the StRAP is generally designed to be responsive to the partner research needs.
- During the in-person subcommittee meeting, representatives of various program offices (EPA's Office of Pollution Prevention and Toxics [OPPT], Office of Pesticide Programs [OPP], Office of Water [OW], OLEM, and Office of Science Coordination and Policy [OSCP]) discussed their programmatic needs; the ways in which they are, or envision, using CSS products to fulfill their

duties; and where collaboration between program offices and CSS is occurring. Dr. Frithsen also identified ongoing dialogue with regional science liaisons and Superfund Technical Support Centers. These presentations highlight the constructive and ongoing engagement between CSS and EPA program offices. Unlike at prior meetings of the subcommittee, no regional office representatives were present at the meeting, raising the question of whether the regions and states have been de-prioritized compared to prior StRAPs.

- EPA's Regional Applied Research Effort (RARE) represents an Agency program to engage regional offices in collaborative research with ORD experts. The project "Application of 21st century bioanalytical tools to identify sources and effects of bioactive contaminants associated with select municipal wastewater discharges to the South Platte and Colorado River watersheds" is an especially exciting RARE collaboration between CSS and EPA region 8. Some of the poster presentations highlighted other important collaborations to ensure the effective use of CSS research by EPA regions (e.g., RapidTox). This effort illustrates the value of strong partnerships with regions and states.

**Suggestions**

- There are many references to external stakeholders in the StRAP. For example, the StRAP makes reference to developing a research agenda that aims to solve "the problems encountered by Agency partners and stakeholders" and that the StRAP "evolved through a series of meetings, workshops, and consultations with Agency partners, ORD scientists, and interactions with external stakeholders." However, the StRAP document does not describe who these specific external stakeholders are nor what types and how interactions with stakeholders informed the direction of the StRAP. To the extent, the StRAP was designed to responsive to stakeholder needs in addition to EPA partner needs, it is important that these stakeholders be defined and more discussion provided of how their needs were identified and used to inform the StRAP.
- The CSS-HHRA partner relationship is unique and especially valuable for increasing use of NAMs in risk assessment. Among other critical roles, HHRA serves an important intermediary for evaluating, piloting, and advancing the use of NAMs in risk assessment and translating such learnings and experience to risk assessment practitioners on the ground that include agency partners. CSS should include HHRA in its partner outreach efforts to identify opportunities for advancing the use of NAMs in risk assessment. For example, HHRA could be very helpful in evaluating/validating the outcomes of NAMs toward building confidence in their use in risk assessment, including where they can appropriately be used to reduce or replace the use of animals. Similarly, CSS could engage with HHRA to identify gaps in the data available for current risk assessments that might be informed by NAM outputs.
- EPA's Office of Chemical Safety and Pollution Prevention (OCSPP) is CSS's primary partner, but CSS products and tools are of immense value and relevance to all Agency partners looking for solutions related to chemical assessment and decision-making. Ideally, CSS would pursue research in a manner that serves the needs of all of its partners and frame CSS products in a way that conveys their utility to multiple partners. CSS could specify how each of its products can be directed toward answering specific partner questions and helping to provide solutions for specific partner needs.
- Ongoing education and training, ideally involving beta testing and piloting of CSS products, is essential to encouraging confidence in the products and their adoption for use by CSS partners and stakeholders, such as industry, academia, NGOs, and the public. Widespread use of CSS products will lead to constructive input that, in turn, will lead to more scientifically robust and useful products over time.

- CSS could explore opportunities to work with relevant program offices to use the high-throughput new exposure modeling tools to identify potential emerging contaminants.
- CSS could work with the program offices to develop a set of principles and approaches for establishing scientific confidence for the methods and new data streams to meet the different program office decision contexts. These scientific confidence principles and approaches should be scientifically robust and yet sufficiently flexible to enable application across tools, models and methods and decision contexts.
- The CSS program should develop more specific measures for integrating input from its partners as well as other potential users of its products throughout the research project life cycle. These measures should include more proactive interaction during the problem formulation and research design stage with stakeholders and partners to align needs and anticipate issues. Also, such measures may include more extensive beta testing of research products with potential users prior to their broader release. Beta testing may be an incentive for researchers to get involved in testing new tools or modifications to existing tools by gaining early access. This also encourages stakeholder feedback at early stages of tool development to ensure that these products are meeting their needs.

## Recommendations

The subcommittee offers the following recommendations to capitalize on engagement with CSS partners to identify priority research needs.

**Recommendation 1b.1:** For the *current* StRAP, develop a partner engagement plan as described in Recommendation 1b.5, solely for the purpose of soliciting feedback from partners regarding *implementation* of the CSS StRAP.

*EPA Response: We agree with this recommendation and note that ORD has set the expectations for continuous partner engagement in research planning and implementation across all the National Research Programs. Although outside of the scope of the StRAPs, implementation planning has already commenced. ORD has formed coordination teams for each research area and these teams include representatives from EPA programs and regions. The research area coordination teams (RACTs) have worked to provide further definition for the outputs described in the StRAPs and have defined specific products that will be needed to meet output objectives. The RACTs are also working to define specific partner engagement plans. The RACT infrastructure will be maintained during the research implementation phase, albeit at less strenuous level of engagement and allowing for flexibility in partner engagement processes. Research outputs and products have been loaded into ORD's electronic Research Approval Planning Implementation Dashboard (RAPID) and will be available to Agency partners through the ORD Research Management System (RMS). Through periodic meetings of the RACTs and the availability of RAPID, ORD will be able to provide engagement with partners throughout the research implementation and delivery process.*

**Recommendation 1b.2:** For the *current* StRAP, identify a set of activities that CSS will pursue to advance partner education, training, and piloting of CSS products.

- Coordinate with HHRA to support this effort; HHRA has long-standing relationships with EPA regional offices and states through its superfund technical support networks and could assist with training and educating practitioners on CSS products.

- Continue and strive to expand on the RARE effort and report to the subcommittee and CSS partners on the results, including achievements and lessons learned for CSS product transfer to Region 8 and other partners.
- Take advantage of CSS's work on per- and polyfluoroalkyl substances (PFAS) as an opportunity to educate and train partners, including piloting of CSS products.

*EPA Response: We agree with this BOSC recommendation and note that the research area specific partner engagement plans will address outreach efforts more specifically. These specific plans are outside of the scope of the StRAP. The plans will integrate with ongoing outreach and training activities related to CSS products such as: the Comptox Chemicals Dashboard (comptox.epa.gov/dashboard); the ECOTOX Knowledgebase (cfpub.epa.gov/ecotox); SeqAPASS (https://www.epa.gov/chemical-research/sequence-alignment-predict-across-species-susceptibility); and the AOP Wiki and AOP Knowledgebase.*

*We also agree that more coordination/collaboration between CSS and HHRA/HERA is needed to effectively educate, train, and pilot CSS products. Coordination and collaboration between the two national research programs is ongoing and the BOSC Subcommittee was introduced to several efforts (such as RapidTox) during the April 2019 review meeting. CSS and HERA will continue to work closely to align research activities so as to better meet the needs of Agency programs and regions, states, tribes, and other stakeholders.*

*We agree with the recommendations pertaining to the RARE program. RARE projects are regionally-initiated activities and are funded through allocations outside of the CSS program. RARE proposals are of an applied nature, by design, and the regions typically are more active in those research programs that have significant aspects of the enabling legislation that delegates activities to regions and/or states (e.g., Clean Water Act, Clean Air Act), rather than in the CSS domain where there are fewer delegated authorities under our major legislative mandates (TSCA, FIFRA, FQPA).*

*Opportunities to educate, train, and pilot CSS PFAS products are particularly important given that PFAS chemicals are a high priority for the Agency and for our state stakeholders. CSS investment in PFAS research is growing and includes collaborations outside of the Agency. PFAS research in other ORD National Research Programs is substantial and complementary to CSS efforts. As these efforts move forward, we will seek opportunities from all the contributing national research programs to educate, train, and pilot ORD products.*

**Recommendation 1b.3:** For the *current* StRAP, develop a set of activities to pursue regarding broad stakeholder outreach and engagement around CSS research and products with the goal of building confidence in CSS products. This confidence will, in turn, promote the acceptance and use of the products in risk assessment and regulatory decision-making for the protection of human health and the environment.

*EPA Response: We agree with this recommendation. It is particularly relevant to NAMs research in CSS. CSS research efforts on the development, testing, and application of NAMs is driven by specific partner needs, supports activities outlined in the June 2018 TSCA alternative toxicity testing strategy (https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/strategic-plan-reduce-use-vertebrate-animals-chemical), and is responsive to the September 2019 Administrator's directive to reduce the use of mammalian testing for chemical safety assessments by 30% by 2025. NAMs will be employed to more rapidly assess the impacts of data-poor emerging contaminants, such as the per- and*

*polyfluorinated chemicals (PFAS). Recognizing the broad applicability of the NAMs and the need to build sufficient confidence to facilitate their use in decision making, CSS scientists are engaged in numerous activities, including:*

- *Accelerating the Pace of Chemical Risk Assessment (APCRA) working group that is focused on building demonstrative case studies focused on moving NAMs into decision making. This International working group led by ORD includes: CSS and HERA scientists, the major offices of OCSPP, OW, and OLEM, as well as the European Chemicals Agency, European Food Safety Agency, European Joint Research Centre, Health Canada, Environment and Climate Change Canada, and others.*
- *Groundbreaking work in use of high-throughput toxicology and rapid exposure and modeling methods for the evaluation of:*
    - *Developmental neurotoxicity (DNT)*
    - *Transcriptomics for toxicological evaluations*
    - *Endocrine disruption testing for chemicals and pesticides*
    - *Translator models for ecotoxicology*
    - *Inhalation toxicology.*

*Other examples are being pursued throughout the CSS program at various scales. A common theme is to undertake case-studies in close collaboration and/or consultation with partners, particularly those in the user and decision-making communities.*

**Recommendation 1b.4:** The *current* StRAP should include discussion of how the work in CSS relates to other research activities at ORD, and how the research agenda was informed by the needs of these other research programs, particularly the HHRA program activities.

*EPA Response: The section of the StRAP addressing integration and collaboration across National Research Programs (NRP) is brief and will be updated to include additional detail, particularly regarding interconnections with the HERA (previously HHRA) NRP. The areas that are relatively rich in collaborative activities include:*

- *Applying tiered-testing approaches to address data poor chemicals;*
- *Coordinating and sharing developments in PFAS-related research;*
- *Improved access to CSS digital information products, such as CompTox Chemicals Dashboard and ECOTOX Knowledgebase, and;*
- *Developing relevant RAPIDTOX workflows for program-specific scenarios.*

**Recommendation 1b.5:** For *future* StRAPs, develop a deliberate partner engagement plan that details the process that will be undertaken to identify partner needs, recognizing that priorities and needs may shift over time. The plan should include 1) how partners will be engaged, 2) how input from partners will be solicited, and 3) how identified needs will be prioritized for inclusion in the CSS StRAP. CSS should seek guidance from partners as to how they would like to be included in the research planning process and then tailor the plan as needed to specific partner groups. With this recommendation, the subcommittee does not intend to impose an onerous process on CSS that unnecessarily detracts from its excellent research. Instead, CSS should define an efficient process to allow for the effective elicitation of partner needs while also being transparent to the subcommittee and other reviewers.

*EPA Response: We agree with this recommendation, not just as it pertains specifically to CSS, but rather to the entire ORD portfolio of research and development. ORD engaged in a very rigorous StRAP engagement process with EPA programs and regions, state, tribes, and other stakeholders. Input from these sources, and from ORD researchers, has been very positive, reflecting that the engagement was*

*successful, appreciated, and that partner needs have been heard and will be addressed. However, there was also input that the planning process was quite resource intensive for both ORD and our partners. Our experiences with the development of the FY2019-FY2022 StRAP will inform development of future StRAPs.*

*The engagement process is also being accomplished through more detailed research planning and implementation. Specifically, EPA program and regional scientists, and several state scientists, were central to the development of the research area descriptions developed by the Research Area Coordination Teams. The partners participated in reviewing and revising the strategic outputs and these revisions are reflected in the CSS StRAP revision. EPA program, regional, and state scientists were then engaged with defining specific products to ensure that there is alignment with their needs and to build awareness and confidence in the research. Their ultimate involvement is scalable to ensure that their engagement is at an appropriate level. For example, a high degree of involvement would be expected on case-studies that are dependent on close collaboration. Conversely, some products only require periodic involvement as determined by EPA program and region, state, and tribal interests and needs.*

## Charge Question 1c

> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

**Narrative**

The subcommittee was impressed with the clarity and coherence of the strategic vision of the program. The research as outlined and the proposed outputs in the CSS StRAP 2019–2022 clearly define the desired research vision of the CSS program. The informatics and database developments over the last 3 years along with the continued enhancement and updating are exceptional and will provide detailed and accurate information sources for partners, stakeholders, and the public for chemical safety evaluation. These programs will clearly be the international model for chemical resource data to protect human health and the environment.

The current StRAP emphasizes modeling and computational approaches and appears to de-emphasize measurement approaches. For example, the Rapid Exposure Modeling and Dosimetry (REMD) research area only includes a brief mention of analytical chemistry research areas (environmental monitoring, non-targeted testing), and the document overall contains greater emphasis on computational toxicology than on chemical testing approaches (high-throughput, medium-throughput, and high-content). Although the progress on computational approaches is impressive, the subcommittee believes that the analytical chemistry and biological activity testing activities at CSS need more emphasis in the StRAP.

The StRAP does not contain much specific discussion of work going on related to susceptible populations, including children, workers, and affected communities. Children are mentioned only under the heading "Integration Among Research Programs" on p. 25 of the StRAP. The paragraph related to susceptible subpopulations should be described more clearly and included under a more appropriate heading, in order to increase clarity in the document.

The research area on Emerging Materials and Technology is currently rather thin, containing only two strategic outputs, and focusing only on nanomaterials. This area could easily be enhanced to incorporate

*successful, appreciated, and that partner needs have been heard and will be addressed. However, there was also input that the planning process was quite resource intensive for both ORD and our partners. Our experiences with the development of the FY2019-FY2022 StRAP will inform development of future StRAPs.*

*The engagement process is also being accomplished through more detailed research planning and implementation. Specifically, EPA program and regional scientists, and several state scientists, were central to the development of the research area descriptions developed by the Research Area Coordination Teams. The partners participated in reviewing and revising the strategic outputs and these revisions are reflected in the CSS StRAP revision. EPA program, regional, and state scientists were then engaged with defining specific products to ensure that there is alignment with their needs and to build awareness and confidence in the research. Their ultimate involvement is scalable to ensure that their engagement is at an appropriate level. For example, a high degree of involvement would be expected on case-studies that are dependent on close collaboration. Conversely, some products only require periodic involvement as determined by EPA program and region, state, and tribal interests and needs.*

## Charge Question 1c

> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

**Narrative**

The subcommittee was impressed with the clarity and coherence of the strategic vision of the program. The research as outlined and the proposed outputs in the CSS StRAP 2019–2022 clearly define the desired research vision of the CSS program. The informatics and database developments over the last 3 years along with the continued enhancement and updating are exceptional and will provide detailed and accurate information sources for partners, stakeholders, and the public for chemical safety evaluation. These programs will clearly be the international model for chemical resource data to protect human health and the environment.

The current StRAP emphasizes modeling and computational approaches and appears to de-emphasize measurement approaches. For example, the Rapid Exposure Modeling and Dosimetry (REMD) research area only includes a brief mention of analytical chemistry research areas (environmental monitoring, non-targeted testing), and the document overall contains greater emphasis on computational toxicology than on chemical testing approaches (high-throughput, medium-throughput, and high-content). Although the progress on computational approaches is impressive, the subcommittee believes that the analytical chemistry and biological activity testing activities at CSS need more emphasis in the StRAP.

The StRAP does not contain much specific discussion of work going on related to susceptible populations, including children, workers, and affected communities. Children are mentioned only under the heading "Integration Among Research Programs" on p. 25 of the StRAP. The paragraph related to susceptible subpopulations should be described more clearly and included under a more appropriate heading, in order to increase clarity in the document.

The research area on Emerging Materials and Technology is currently rather thin, containing only two strategic outputs, and focusing only on nanomaterials. This area could easily be enhanced to incorporate

additional emerging issues. For example, the research into 3-D printing has important health relevance, and work on microplastics would fit well into this research area.

The subcommittee was impressed with the work presented on Adverse Outcome Pathways (AOPs) in the poster session, but much of that work is not reflected in the StRAP, raising concerns with whether that work is being deemphasized. For example, work to obtain formalin-fixed samples from prior toxicology studies to evaluate early biological markers, and work on mRNA markers is important for helping to establish and validate AOPs and to increase confidence in their use, but it is not described in the StRAP.

**Strengths**

- The StRAP is very clear, readable, and strategic. It provides a coherent structure for the research agenda of the program.
- The three-year objectives of the program are measurable and potentially feasible in the time frame provided.
- The StRAP describes a research agenda that is ambitious and relevant to near-term policy decisions.
- The alternative, non-vertebrate chemical testing program, such as the virtual tissue program and high-throughput testing is well-known and supported by all international regulatory groups.
- The StRAP describes a commitment to ensuring transparency and collaborating with partners and stakeholders at various stages of the product development and implementation process. One such example of this approach is the collaborative process by which Computational Toxicology (CompTox) Chemicals Dashboard has been developed and rolled out to users.

**Suggestions**

- The StRAP should clarify how this research agenda relates to other ongoing research by Federal agencies, such as NTP on related issues, and how CSS is partnering with NTP to advance NAMs.
- Consider adding more detail to the StRAP on important ongoing work on emerging materials and technologies and on AOPs.
- It is unclear what research efforts will be focused on complex substances, UVCBs, and mixtures. Perhaps a needs assessment discussion with relevant program offices is warranted, but the subcommittee would like to see some discussion of this issue in the StRAP.
- It is likely that not all tools, models, and the informatics infrastructures contained in the current StRAP goals can be completely finished and established during the 2019–2022 time frame. Accordingly, there should be milestones in implementation for all products.
- One of these milestones might be to enhance AOPs into a quantitative and robust systems biology network/infrastructure where major environmental safety issues and new testing strategies can be covered by specific AOPs. For example, specific quantitative AOPs could be established for NAMs using virtual tissue models. This would allow the quantification of key events that would serve as biomarkers which would then provide a level of evidence and reduce the uncertainty of the model screening output. Critically, the development of quantitative AOPs must reflect and account for real-world variability in biological responses across the population that result from differences in various endogenous (e.g., age, genetics, pre-existing conditions) and exogenous (e.g., exposure to other agents) factors.
- Another suggested priority would be to enhance the capability of predicting internal exposure from environmental chemical exposure in different species. This could be done by coupling an in vitro/in vivo extrapolation (IVIVE) with several data generating models, including those where

complex mixtures are screened. This could then eventually become a standard part of the AOP Knowledgebase informatics infrastructure and also enhance the ECOTox Knowledgebase.

## Recommendations

The subcommittee offers the following recommendations to more clearly and coherently describe the research agenda of CSS in the StRAP.

**Recommendation 1c.1:** Biological activity testing and analytical chemistry efforts in the CSS research portfolio needs to be more clearly described in the StRAP.

*EPA Response: While we appreciate the BOSC's interest in more specificity to better understand the CSS portfolio of research, our approach for the StRAP was to identify and define strategic outputs that do not over-specify research activities and risk inhibiting development of novel approaches to the stated needs. The level of detail sought under this recommendation has been addressed over recent months through the RACT structure to develop research product descriptions. CSS research occurs in a very dynamic area of science and we have taken this approach to empower our scientists to determine the best specific approaches to pursue, based on their knowledge of their respective fields. The specific research proposals are then reviewed by the NPD, Center management, and EPA programs and regions to ensure that the specific products are responsive to the priorities of the programs.*

*Following are some selected outputs that demonstrate a clear objective without over-specifying the scientific approaches:*

- *Output HTT-2: Develop, evaluate, apply, and interpret a developmental neurotoxicity (DNT) battery of assays to reduce uncertainties in chemical safety evaluations.*
- *Output REMD-6: Further development of high-throughput toxicokinetic (HTTK) tools to support in vitro to in vivo extrapolation. Tools to be developed include those needed to address current sources of uncertainty, challenging chemistries, new exposure routes (e.g., inhalation), and the unique exposures received by sensitive subpopulations.*
- *Output AOP-7: Develop AOPs relevant to human health and ecological impacts of perfluoroalkyl substances (PFAS) and evaluate applicability across species, chemical groupings, and mixtures.*
- *Output ETAM-1: Develop and apply models to translate data from submitted studies into input for models that estimate population- and landscape-level impacts of pesticide use.*

*Much of the additional detail sought by the BOSC on products will be evident when the research area descriptions are made available at future BOSC subcommittee meetings during which BOSC members will have the opportunity to directly interact with ORD scientists.*

**Recommendation 1c.2:** The StRAP should include discussion of work in CSS that is relevant to susceptible subpopulations, including early life stages and those with underlying sensitivities, or highly exposed subpopulations, such as worked or affected communities.

*EPA Response: The Sustainable and Health Communities (SHC) National Research Program has a core focus on protecting susceptible subpopulations and highly exposed communities. With regard to the CSS research program, we also agree with this recommendation and will include additional language in the StRAP to reflect programmatic and statutory requirements. For example, recent revisions to TSCA define 'potentially exposed or susceptible subpopulation' as "…a group of individuals within the general population identified by the Administrator who, due to either greater susceptibility or greater exposure,*

*may be at greater risk than the general population of adverse health effects from exposure to a chemical substance or mixture, such as infants, children, pregnant women, workers, or the elderly''. Several CSS research areas include products that address potentially exposed or susceptible populations, including:*

- *REMD: occupational exposure models;*
- *AOP: consideration of age, sex, genetic, and epigenetic susceptibility factors in several products, and;*
- *VTM research products in all three strategic outputs address developmental toxicity in human embryos.*

## Charge Question 1d

Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

**Narrative**

ORD is well positioned to assist EPA programs with their research initiatives, especially those that fall across multiple programs (e.g., focus on AOPs). ORD is also in a unique position to take a broader research view for protecting human health and the environment. As such, the ORD needs to further engage with individual clients to identify emerging needs that could impact all partners a need to be considered as a whole. For example, the Office of Pesticides is mandated to conduct cumulative risk assessment for groups of pesticides with similar modes of action. Such groupings are generally not based on human relevant exposures, but on individual chemicals or classes. Evidenced by pesticide use patterns across the growing seasons and from human biomonitoring data, humans are exposed to pesticides from multiple chemical classes.

Currently, much of the focus of the CSS is towards single chemical evaluations (CompTox, AOPs) something very important and relevant to protect human health and the environment. However, ORD should also include the human relevant step of consideration of mixtures. This may be in the evaluation of constructed mixtures based on, for example, National Health and Nutrition Examination Survey (NHANES)-based typical concentrations across chemical classes. Such a constructed mixture could be used in a quality control step to evaluate the AOP framework in constructing points of departure (PODs) when exposure is to mixtures. It would be useful to extend the AOP approach being used for mixtures for ecological health by using biomonitoring studies.

ORD should add biomonitoring equivalent values, when available, on the CompTox for readily available guideline values based on human biomonitoring concentrations. This will provide an opportunity for epidemiologists to access regulatory values relevant to their biomonitoring data. Multiple stressors may also include non-chemical stressors.

The data supporting CompTox seems to be largely from in vitro and in vivo data. There are publicly available human health and exposure data that could be incorporated. One example is the NHANES database – which is limited to a cross-sectional design. A valuable impending source is the CHEAR (Child Health Exposure Assessment Resource) data repository, the National Institute of Environmental Health Sciences (NIEHS)-funded network of a national exposure assessment laboratory network, including epidemiologic data provided by study principal investigators and targeted environmental chemical panels.

Importantly, many of the CHEAR studies include metabolomics data on study samples (from maternal and child samples).

**Strengths**

- Work on sources of exposure is important and demonstrates multiple sources of exposure for many chemicals.
- The dosimetry between in vitro and in vivo concentrations is very important and relevant to risk assessment.
- The research on PFAS chemicals provides an opportunity to consider applicability across chemical groupings and mixtures.
- There is great evidence on the cross-research collaboration between ORD groups/projects for the successful delivery of NAMs. Current research seems to be aligned and moving forward.
- Regarding method validation/accuracy, ORD has taken steps to approach other global regulatory agencies to collect input and share data

**Suggestions**

- The Influential Science Information (ISI) needs greater support to accommodate the need for computational tools that need to be consistently updated and reviewed as new data become available. Models cannot be static. The efficiency of the process would be improved with machine learning and artificial intelligence.
- ORD CSS should collaborate with OCSPP to evaluate ways to improve methods, models, scientific approaches in EPA's new chemicals program (EpiSuite was noted as having many issues). To include an evaluation of the CSS pre-prioritization proof of concept methods that may be applied in the new chemicals program and TSCA Section 4 (chemical testing), such as GenRA, threshold of toxicological concern, etc.
- The EAM theme should be expanded to include nano-plastics and 3-D printer byproducts.

## Recommendations

The subcommittee offers the following recommendations to invest in other critical emerging environmental needs or fields of expertise or new research methods.

**Recommendation 1d.1:** High-throughput testing should include mixtures of chemicals identified from biomonitoring studies, and other health- and ecologically-relevant mixtures.

*EPA Response: We agree that evaluating mixtures with high-throughput approaches is an important consideration. This recommendation is similar to the recommendation above (1a.2), but more focused on high-throughput testing. Relevant examples are provided in the response to recommendation 1a.2.*

**Recommendation 1d.2:** ORD should ensure that there is sufficient digital and in-silico technology expertise to support computational predicting tools. ORD needs to have the staff expertise needed to support the shift from experimentation to computational/in-silico predicting approaches to address the EPA mandate.

*EPA Response: We agree with this recommendation as it is a continuing issue for ORD that has been exacerbated by the challenges of attracting and retaining computational and information technology scientists to the federal workforce. Several ORD organizations have made this a priority area for staff recruitments. The recent ORD reorganization centralizes much of the CSS research into a large ORD Center that is already increasing its capability and capacity in the areas of chemical informatics and information technologies. One important and relevant change in the current StRAP is the new research area: Informatics, Synthesis, and Integration (ISI). ISI now more explicitly addresses the informatic issues and needs than in the past and has realized a tripling of its budget allocation for FY2020 to improve the digital infrastructure and the relevant expertise to operationalize the digital vision of the program.*

## Charge Question 1e

> Q.1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

**Narrative**

The CSS program appears committed to responding to the evolving needs of its partners and stakeholders through innovative research and the development of models, tools and other products to address existing and emerging environmental problems. As discussed above with respect to the prior charge questions, the research products play a critical role in enabling the Agency to meet its statutory obligations and strategic goals. However, creation of the research products is only one aspect of innovation; the products are only useful if adopted and appropriately implemented by the intended end-users. The CSS StRAP indicates that the program seeks input from its partners through a range of methods, including planned partner engagement at points during the research process and evaluation of the usefulness and effectiveness of the research products. However, the nature and scope of those activities are not described in detail within the StRAP.

The program rightly recognizes that its efforts are bounded by resource constraints and that the knowledge generation and innovation required exceeds the capacity of one program. It uses a variety of strategies to foster innovation relevant to its research priorities, including extramural activities that

leverage the resources of other government programs, academic institutions, non-governmental entities and business. Examples include extramural grants such as the EPA's STAR grant program, RARE, innovation challenges, and interagency and international collaboration and outreach. These strategies and others like them are not costless; the value they bring to the program must be balanced against the opportunity costs they present. It is also unclear the extent to which funds will continue to be available to support such opportunities in the future.

**Strengths**

- The program appears to recognize that adoption and use of its research products are strongly linked with social, institutional, and other factors aside from the scientific and technical benefits of the products. For example, planned research highlights for the AOP project includes identifying and implementing solutions to social, institutional, and IT barriers to AOP development and use.
- The STAR grant program and cooperative agreements have been key drivers of innovation. STAR grants in particular enhance and supplement the program's in-house research while building capacity and collaborations among academic scientists and engineers. As an example, the Organotypic Culture Methods Centers represent a collaboration across six different universities that focuses on developing alternative test methods using physical and computational models of biological tissues. This active collaboration is contributing to scientific innovations through the development of novel toxicity screening tools.

**Suggestions**

- The program (and the Agency more generally) should continue (and increase) its utilization of STAR grants and cooperative agreements to fill critical capability gaps, rather than attempting to recreate them all in-house.
- The development and use of AOP frameworks has been rapidly increasing in recent years. However, there remains a need to incentivize the posting of AOPs in shared database sites, such as AOPWiki, to increase accessibility, uptake, and use of models. The CSS program should consider incentivizing such contributions through simplified formatting requirements. Ensuring that databases are easy to use and require minimal time and effort will encourage greater participation among the researcher community.
- The CSS program should consider sponsoring and participating in a continuing workshop or colloquium series with one or more academic partners or professional/scientific societies focusing upon priority research topics. As an example, the U.S. Food and Drug Administration (FDA) has paired with the Society of Toxicology (SOT) since 2014 to present regular colloquia regarding innovative work in toxicological science relevant to the work of the FDA. A similar series featuring a partnership between the EPA and an external organization could greatly enhance the capacity of scientists and engineers within and outside the program, generate new collaborations, and drive novel scientific innovations.
- Building capacity and an informed public begins with education at all levels, from K-12 through graduate-level training. If feasible, the CSS program should consider cost-effective efforts to incentivize and assist in the development of appropriate curriculum relating to the areas covered by program research topics. Efforts could include development of curriculum and case studies by the program or program grantees as well as collaboration with educational institutions, professional societies and accreditation bodies. As an example, EPA's OLEM has developed environmental education materials geared at teaching both children and adults about the environment and issues such as Superfund sites. Resources include learning activities, environmental cleanup videos, and collaboration opportunities with EPA scientists.

- The CSS program should consider offering additional training in science communication to the CSS staff for preparation of materials or when interacting with the public regarding its scientific discoveries or sharing mission objectives related to the goals of protecting environmental and ecological health.

## Recommendations

The subcommittee offers these two recommendations to capitalize on specific ideas for innovation and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems.

**Recommendation 1e.1:** The CSS program should strategically seek out opportunities to expand and increase the use of grant programs such as the STAR and SBIR programs to drive research and innovation. These programs allow the program to leverage external funds by collaborating with other agencies and other external partners.

*EPA Response: We support and utilize the STAR grant program to fuel scientific investigations in targeted areas of research generally relevant to the field of toxicology and chemical safety. The level of funding allotted to STAR, and hence to topics germane to the CSS program, has been informed over recent years through Congressional appropriations language. Agency research needs and priorities drive the selection of topics for STAR solicitation and early reviews of request for assistance (RFA) proposals. CSS will continue to participate in the STAR program subject to resource availability. Recent RFAs have been directed to high priority issues, including developing NAMs and improvements in HTTK methods. Regarding SBIR, ORD, through its Office of the Science Advisor, Policy, and Engagement (OSAPE), will be looking across various research support opportunities, including the SBIR opportunity.*

**Recommendation 1e.2:** The CSS program should consider developing an integrated suite of challenge/prize and recognition programs for partners and stakeholders who may invest in or use research products being developed by the program. In particular, it may be helpful to allocate resources for such programs for *each* of the research areas to fund necessary R&D that does fall within the stated expertise areas of the Agency. This suite could build upon the experience gained through existing and prior programs. For example, the Transform Toxicity Challenge asked scientists to develop techniques to rework existing high-throughput screening assays to incorporate metabolism of chemicals. Likewise, recognition programs provide incentives and affirmation to entities whose research and activities complement those of the program. Challenge and awards programs offering modest awards and recognition for graduate and post-graduate students should also be considered across each of the research areas.

*EPA Response: We agree with the suggestion to encourage innovation by increasing funding for challenge grants and prize money. CSS recently launched an ECOTOX TARGET Challenge to look for new technologies to screen chemicals for potential ecological hazards. The challenge aims to address the ecological gap in EPA's high-throughput screening program by developing high quality and low-cost technologies for measuring global gene expression in samples from four listed ecological species representing fish, invertebrates, plants, and algae. Recognizing this as one approach to stimulate innovation, CSS must also balance its support of intramural and extramural activities. For ORD as a whole, the innovation staff in OSAPE will be preparing an internal strategy on how ORD can best coordinate and implement open innovation concepts, linked with other non-traditional research opportunities such as SBIR.*

## SUMMARY LIST OF RECOMMENDATIONS

This section provides a listing in a single location of the recommendations provided earlier in the report in response to each charge question.

### Charge Question 1a. Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

- **Recommendation 1a.1:** We recommend that the effort to include early stage life-cycle analysis (LCA) as a decision-making tool along with on-going work should not be de-emphasized as it would appear to be both needed and cost effective. A de-emphasis on early stage LCA and sustainable chemistry may impact the ability to evaluate emerging chemicals and materials, and to compare alternatives. However, the current research effort is developing many of the elements of early stage LCA, including chemical screening and ecosystem impact tools.
- **Recommendation 1a.2:** Toxicological evaluation of chemical mixtures, based on common chemical co-exposure, should have a higher priority. This should augment the current focus on individual chemical species or chemical groups so that future efforts include exposures and use of materials that include complex mixtures of chemicals. The StRAP should present better articulation and inclusion of mixtures in case studies and strategic outputs.

### Charge Question 1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

- **Recommendation 1b.1:** For the *current* StRAP, develop a partner engagement plan as described in Recommendation 1b.5, solely for the purpose of soliciting feedback from partners regarding *implementation* of the CSS StRAP.
- **Recommendation 1b.2:** For the *current* StRAP, identify a set of activities that CSS will pursue to advance partner education, training, and piloting of CSS products.
  - Coordinate with HHRA to support this effort; HHRA has long-standing relationships with EPA regional offices and states through its superfund technical support networks and could assist with training and educating practitioners on CSS products.
  - Continue and strive to expand on the RARE effort and report to the subcommittee and CSS partners on the results, including achievements and lessons learned for CSS product transfer to Region 8 and other partners.
  - Take advantage of CSS's work on per- and polyfluoroalkyl substances (PFAS) as an opportunity to educate and train partners, including piloting of CSS products.
- **Recommendation 1b.3:** For the *current* StRAP, develop a set of activities to pursue regarding broad stakeholder outreach and engagement around CSS research and products with the goal of building confidence in CSS products. This confidence will, in turn, promote the acceptance and use of the products in risk assessment and regulatory decision-making for the protection of human health and the environment.
- **Recommendation 1b.4:** The *current* StRAP should include discussion of how the work in CSS relates to other research activities at ORD, and how the research agenda was informed by the needs of these other research programs, particularly the HHRA program activities.
- **Recommendation 1b.5:** For *future* StRAPs, develop a deliberate partner engagement plan that details the process that will be undertaken to identify partner needs, recognizing that priorities

and needs may shift over time. The plan should include 1) how partners will be engaged, 2) how input from partners will be solicited, and 3) how identified needs will be prioritized for inclusion in the CSS StRAP. CSS should seek guidance from partners as to how they would like to be included in the research planning process and then tailor the plan as needed to specific partner groups. With this recommendation, the subcommittee does not intend to impose an onerous process on CSS that unnecessarily detracts from its excellent research. Instead, CSS should define an efficient process to allow for the effective elicitation of partner needs while also being transparent to the subcommittee and other reviewers.

Charge Question 1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

- **Recommendation 1c.1:** Biological activity testing and analytical chemistry efforts in the CSS research portfolio needs to be more clearly described in the StRAP.
- **Recommendation 1c.2:** The StRAP should include discussion of work in CSS that is relevant to susceptible subpopulations, including early life stages and those with underlying sensitivities, or highly exposed subpopulations, such as worked or affected communities.

Charge Question 1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

- **Recommendation 1d.1:** High-throughput testing should include mixtures of chemicals identified from biomonitoring studies, and other health- and ecologically-relevant mixtures.
- **Recommendation 1d.2:** ORD should ensure that there is sufficient digital and in-silico technology expertise to support computational predicting tools. ORD needs to have the staff expertise needed to support the shift from experimentation to computational/in-silico predicting approaches to address the EPA mandate.

Charge Question 1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

- **Recommendation 1e.1:** The CSS program should strategically seek out opportunities to expand and increase the use of grant programs such as the STAR and SBIR programs to drive research and innovation. These programs allow the program to leverage external funds by collaborating with other agencies and other external partners.
- **Recommendation 1e.2:** The CSS program should consider developing an integrated suite of challenge/prize and recognition programs for partners and stakeholders who may invest in or use research products being developed by the program. In particular, it may be helpful to allocate resources for such programs for *each* of the research areas to fund necessary R&D that does fall within the stated expertise areas of the Agency. This suite could build upon the experience gained through existing and prior programs. For example, the Transform Toxicity Challenge asked scientists to develop techniques to rework existing high-throughput screening assays to incorporate metabolism of chemicals. Likewise, recognition programs provide incentives and

affirmation to entities whose research and activities complement those of the program. Challenge and awards programs offering modest awards and recognition for graduate and post-graduate students should also be considered across each of the research areas.

## CONCLUSIONS

The program has a variety of measures in place that support the creation and adoption of innovative tools and methods that are central to the Agency's mission. These measures could be enhanced by considering strategic expansions in scope or use. The research as outlined and the proposed outputs in the CSS StRAP 2019–2022 clearly define the desired research vision of the CSS program. With the continual partner/ stakeholder inputs and collaborations and top-level science at CSS, the program is certainly on track to advance the management of chemical risks in order to protect human health and the environment.

# APPENDIX A: MEETING AGENDA

## United States Environmental Protection Agency
## Board of Scientific Counselors (BOSC)
## Chemical Safety for Sustainability (CSS)/Human Health Risk Assessment (HHRA) Subcommittee

Meeting Agenda – April 10-12, 2019
Research Triangle Park, North Carolina
Room C112

**Wednesday, April 10, CSS Program**

| | | |
|---|---|---|
| 8:00 | Registration | DFO Contractors |
| 8:30 | Welcome, introductions and opening remarks by Subcommittee Chair, EPA DFO and ORD Leadership | Katrina Waters, BOSC Chair<br>Tom Tracy, DFO<br>Bruce Rodan, Associate Director for Science, ORD |
| 9:00 | Overview of agenda, organization of meeting, discussion of background materials, highlights of CSS program. | Jeff Frithsen, ORD, CSS NPD<br>Joe Tietge, ORD, CSS DNPD |
| 10:00 | Review of Charge Questions | Katrina Waters, BOSC Chair |
| 10:15 | Public Comments | Tom Tracy, ORD, DFO |
| 10:30 | Break | |
| 11:00 | Statutory drivers and programmatic needs: Mission-oriented Research to Support Chemical Safety Decision Making: | CSS Team |
| 11:30 | Presentations and Discussions with CSS Program Office Partners: OCSPP (OPPT, OPP, OSCP), OW, OLEM | Agency Partners:<br>Jeff Morris (OCSPP-OPPT)<br>Anna Lowit (OCSPP-OPP)<br>Hayley Hughes (OCSPP-OSCP)<br>Kathleen Raffaele (OLEM)<br>Betsy Behl (OW-OST) |
| 12:30 | Working Lunch: Demonstration of the Agency's Comptox Chemistry Dashboard | Katrina Waters<br>Antony Williams (ORD-NCCT) |
| 1:30 | Research Topic Overview: Chemical Evaluation | CSS Team |
| 2:15 | Research Topic Overview: Complex Systems Science | CSS Team |
| 3:00 | Break | |
| 3:30 | CSS Poster Session and Interactive Demonstrations | CSS Team<br>RTP B Wing Atrium |

| | | |
|---|---|---|
| 5:15 | BOSC Subcommittee Reconvenes | Katrina Waters |
| 5:30 | Meeting concludes for the day | |

**Thursday, April 11, Morning – CSS Program**

| | | |
|---|---|---|
| 8:00 | Registration | DFO Contractors |
| 8:30 | BOSC Subcommittee Convenes: Questions and Clarifications | Katrina Waters |
| 8:45 | Research Topic Overview: Solutions-Based Translation and Knowledge Delivery | CSS Team |
| 9:30 | CSS: Implementation of the CSS StRAP | Jeff Frithsen |
| 10:00 | Break | |
| 10:30 | BOSC Subcommittee Deliberations and Writing: CSS | Katrina Waters |
| 12:00 | Working Lunch | Katrina Waters |

**Thursday, April 11, Afternoon – HHRA Program**

| | | |
|---|---|---|
| 12:00 | HHRA posters and demos available for preview | RTP B Wing Atrium |
| 1:00 | Welcome, introductions and opening remarks by Subcommittee Chair, EPA DFO | Katrina Waters, BOSC Chair Tom Tracy, DFO |
| 1:10 | Research needs and science directions within the Office of Chemical Safety and Pollution Prevention (OCSPP) | Alexandra Dapolito Dunn, Assistant Administrator for EPA's Office of Chemical Safety and Pollution Prevention (OCSPP) |
| 1:30 | Overview of HHRA program and HHRA BOSC engagement. | Tina Bahadori, HHRA NPD |
| 2:00 | Review of Charge Questions through HHRA Lens | Katrina Waters, BOSC Chair |
| 2:15 | HHRA Poster Session and Interactive Demonstrations | HHRA Science Leads<br>RTP B Wing Atrium |
| 4:15 | BOSC Subcommittee reconvene for questions and clarification | Katrina Waters |
| 4:30 | Discussion of next steps for HHRA | Tina Bahadori |
| 4:45 | BOSC Subcommittee deliberations and writing: HHRA | Katrina Waters |
| 5:30 | Meeting concludes for the day | |

**Friday, April 12, BOSC Discussions**

| | | |
|---|---|---|
| 8:00 | Registration | DFO Contractors |
| 8:30 | BOSC Subcommittee Convenes: | Katrina Waters |

| | | |
|---|---|---|
| | Questions and Clarifications | |
| 9:00 | BOSC Subcommittee Deliberations and Writing: CSS | Katrina Waters |
| 12:00 | Working lunch: Discussion time for BOSC members | Katrina Waters |
| 1:00 | BOSC Subcommittee Deliberations and Writing: HHRA | Katrina Waters |
| 2:00 | BOSC Subcommittee Meeting Adjourns | Tom Tracy |

# APPENDIX B: MATERIALS

## Material Provided in Advance of the Meeting

***Materials to Support the Charge Questions***

- CSS BOSC Meeting Information (to include agenda and charge questions)
- HHRA charge questions
- Draft StRAP (December 21, 2018 version)
- EPA Strategic Plan https://www.epa.gov/planandbudget/strategicplan
- ORD Strategic Plan

***Informational Materials***

- CSS fiscal years 2016-2018 publication information

## Additional Material Provided During the Meeting

- BOSC CSS/HHRA subcommittee roster

BOSC
BOARD OF SCIENTIFIC COUNSELORS

# REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

## BOSC HOMELAND SECURITY SUBCOMMITTEE


Paula Olsiewski, Ph.D. (Chair)
*Alfred P. Sloan Foundation*

Lance Brooks (Vice Chair)
*Defense Threat Reduction Agency*

Charles Barton, Ph.D.
*Valspar Corporation*

Murray Cohen, Ph.D., MPG, CIH
*Frontline Healthcare Workers Safety Foundation Ltd.*

Kari Cutting, M.S.
*North Dakota Petroleum Council*

Andrew DeGraca, PE
*San Francisco Public Utilities*

Shawn Gibbs, Ph.D., MBA, CIH
*Indiana University*

Edward Hackney
*SUEZ (United Water)*

David Klein, Ph.D.
*Texas Tech University*

Debra Reinhart, Ph.D.
*University of Central Florida*

Michael Wichman, Ph.D.
*FDA/ORA Arkansas Regional Laboratory*

Edwin Roehl, MS
*Advanced Data Mining International*

Monica Schoch-Spana, Ph.D.
*Johns Hopkins University Center for Health Security*

Robert Scudder, Ph.D., CIH, CSP, CET
*Mayes County Emergency Management*

Justin Teeguarden, Ph.D.
*Pacific Northwest National Laboratory*

Dana S. Tulis
*U.S. Coast Guard*


EPA Contact
**Tom Tracy, Designated Federal Officer**

August 19, 2019

*A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development*

# CONTENTS

**LIST OF ACRONYMS** ..... **C-4**

**INTRODUCTION** ..... **C-5**

**BACKGROUND** ..... **C-5**

**STRAP RESEARCH OBJECTIVES** ..... **C-6**

**CHARGE QUESTIONS AND CONTEXT** ..... **C-6**

**SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS** ..... **C-7**
Charge Question 1a ..... C-7
Charge Question 1b ..... C-9
Charge Question 1c ..... C-11
Charge Question 1d ..... C-14
Charge Question 1e ..... C-16
Charge Question 2 ..... C-18

**SUMMARY LIST OF RECOMMENDATIONS** ..... **C-21**

**CONCLUSIONS** ..... **C-23**

**APPENDIX A: MEETING AGENDA** ..... **C-24**

**APPENDIX B: MATERIALS** ..... **C-28**
Material Provided in Advance of the Meeting ..... C-28
Additional Material Provided During the Meeting ..... C-28

# LIST OF ACRONYMS

| | |
|---|---|
| A-E | Air and Energy |
| AnCOR | Analysis for Coastal Operational Resiliency |
| BA | *Bacillus anthracis* |
| BOSC | Board of Scientific Counselors |
| CBR | Chemical, biological, radiological |
| CBRN | Chemical, biological, radiological, and nuclear |
| CBRNE | Chemical, biological, radiological, nuclear, and explosive |
| CDC | Centers for Disease Control and Prevention |
| CPVC | Chlorinated Polyvinyl Chloride |
| CRADA | Cooperative Research and Development Agreement |
| CSS | Chemical Safety for Sustainability |
| DWH | Deepwater Horizon |
| EPA | U.S. Environmental Protection Agency |
| ESAM | Environmental Sampling and Analytical Methods |
| FACA | Federal Advisory Committee Act |
| FBI | Federal Bureau of Investigation |
| FY | Fiscal year |
| HHRA | Human Health Risk Assessment |
| HS | Homeland Security |
| HSRP | Homeland Security Research Program |
| INL | Idaho National Laboratory |
| LEPC | Local emergency planning committees |
| LRN | Laboratory Response Network |
| MTBE | Unusually rapid environmental transport |
| NERL | ORD's National Exposure Research Laboratory |
| NHSRC | EPA's National Homeland Security Research Center |
| NIEHS | National Institute of Environmental Health Sciences |
| NOAA | National Oceanic and Atmospheric Administration |
| ORD | EPA's Office of Research and Development |
| PVC | Polyvinyl Chloride |
| RADAR | Remediation Data Repository |
| RTP | Research Triangle Park |
| SERC | State Emergency Response Commission |
| SHC | Sustainable and Healthy Communities |
| SME | Subject matter experts |
| SSWR | Safe and Sustainable Water Resources |
| StRAP | Strategic Research Action Plan |
| USCG | United States Coast Guard |
| WEST | Waste Estimation Support Tool |
| WOW | Water on Wheel |
| WRF | Water Research Foundation |
| WTP | NIEHS' Worker Training Program |

## INTRODUCTION

The mission of the U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) is to provide the best available science and technology to inform and support public health environmental decision-making at the federal, state, tribal, and local levels, addressing critical environmental challenges and anticipating future needs through leading-edge research. ORD's Homeland Security Research Program (HSRP) aims to increase the United States' capabilities to prepare for and respond to releases of oil and hazardous substances into the environment, as mandated by Congress. The hazardous substances involved can include chemical, radiological, nuclear, and biological materials. HSRP is one of the Agency's six highly integrated national research programs. The other five are Air and Energy (A-E), Chemical Safety for Sustainability (CSS), Human Health Risk Assessment (HHRA), Safe and Sustainable Water Resources (SSWR), and Sustainable and Healthy Communities (SHC).

ORD has developed a strategic research action plan (StRAP) to guide each research program. The draft HSRP StRAP, 2019–2022, is a four-year research strategy to deliver research necessary to support EPA's overall mission to protect human health and the environment, fulfill the EPA's legislative mandates, and advance cross-agency priorities identified in the FY2018–FY2022 EPA Strategic Plan. It is the third such strategic planning exercise in this format (previous StRAPs covered 2012–2016 and 2016–2019). The current StRAP evolved through close collaboration with partners in EPA's program offices and regions, other federal agencies, states, and tribes.

Currently, ORD is seeking input from the Board of Scientific Counselors (BOSC) on the draft 2019–2022 StRAP documents and proposed research strategies. The emphasis is on advancing ORD research that can successfully address the needs identified by EPA programs and regions, states, and tribes. This review by the BOSC HSRP subcommittee of the draft HSRP StRAP will be followed by regular BOSC reviews of research activities over the course of the StRAP implementation.

## BACKGROUND

In November 2018, HSRP provided the BOSC HSRP subcommittee with review materials relating to the draft HSRP StRAP and six charge questions to consider when reviewing the materials. Subsequently, the HSRP subcommittee:

1. Reviewed the draft StRAP and related materials (see Attachment B for list of materials);
2. Met with the HSRP National Program Director and program staff on December 12–14, 2018, in Research Triangle Park (RTP), North Carolina, and listened to HSRP presentations (see Attachment A for meeting agenda);
3. Deliberated as a group on the charge questions;
4. Divided into six sub-groups to draft initial responses to each charge question;
5. Deliberated as a group on the draft initial responses and reached consensus on recommendations for all six charge questions during a teleconference on March 19, 2019; and
6. Prepared this report for review by the BOSC Executive Committee in June 2019.

The draft report was submitted to the full BOSC Executive Committee, which met June 27-28, 2019 in RTP, NC to review and discuss draft reports from each of the ORD BOSC subcommittees. The Chair, Vice Chair, and Ms. Kari Cutting of the HSRP subcommittee are members of the Executive Committee; all three

participated in the meeting. The HSRP National Program Director, Dr. Gregory Sayles, participated by teleconference, and Dr. Shawn Ryan and Dr. Sang Don Lee of HSRP were present. They and the members of the BOSC Executive Committee discussed the HSRP subcommittee draft report during the meeting, asked clarifying questions, provided perspective, and offered comments to the HSRP Chair and Vice Chair.

Subsequently, the HSRP subcommittee Chair and Vice Chair made revisions in response to questions and comments raised during the BOSC Executive Committee meeting, as well as the additional information provided during the meeting, and submitted this revised report back to the Executive Committee for their final review.

## STRAP RESEARCH OBJECTIVES

The HSRP StRAP, 2019–2022, is a four-year research strategy designed to meet the following objectives:

> **Research Objective 1:** Advance EPA's capabilities and those of our state, tribal, and local partners to respond to and recover from wide-area contamination incidents; and
>
> **Research Objective 2:** Improve the ability of water utilities to prevent, prepare for, respond to, and recover from water contamination incidents that threaten public health.

EPA's HSRP is organized into three topics supporting these objectives: (1) contaminant characterization and consequence assessment; (2) environmental cleanup and infrastructure remediation; and (3) systems approaches to preparedness and response. Short- and long-term goals accomplished through research areas within these topics outline a strategy for addressing the objectives.

## CHARGE QUESTIONS AND CONTEXT

The HSRP subcommittee was charged with six questions as follows:

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?
>
> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?
>
> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.
>
> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any *other critical emerging* environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

Q.2: Homeland Security Research is designed to address known threats and vulnerabilities. At the same time, the Nation regularly faces unforeseen challenges in public health and the environment (e.g., Ebola and Zika viruses, opioid misuse). Please comment on the extent to which the Program's design enables use of its scientific contributions in also addressing unforeseen needs of the EPA programs and regions, states, and tribes. How can HSRP improve is applicability to unanticipated urgent threats?

## SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

The HSRP subcommittee reviewed the HSRP research over three days in December 2018. The overarching issue addressed by the subcommittee was, "Is HSRP doing the right research?" In other words, how well does the HSRP's current research portfolio address high-priority Agency needs in this area? Taking resource limitations into consideration, should HSRP increase or decrease the emphasis of certain areas of research?

Given limited resources and the urgency of its mission, HSRP must develop a research portfolio that is closely aligned with the high-priority needs of the Agency. The EPA end-users of the program's research work closely with the program to delineate these needs, help define the science questions that must be addressed, advise on the research as it is conducted, and help design and deliver effective products. These high-priority needs are cross-walked with the science questions that are designed to address identified needs. The HSRP subcommittee's review resulted in a series of observations, suggestions, and recommendations, which are described in detail below for each charge question.

### Charge Question 1a

Q.1a. Does the research outlined for the 2019-2022 timeframe <u>support</u> the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

**Narrative**

To answer this question, it is important to review the relevant parts of both the EPA and the ORD Strategic Plans for 2018–2022.

EPA's Strategic Plan for 2018–2022 lists three goals: to deliver clean air and water to the American public to protect human health and the environment; to embrace cooperative federalism; and to follow the rule of law and process. Agency priority goals 2 and 3 for 2018–2019 are particularly aligned with ORD-Homeland Security (HS) research as shared with the HSRP subcommittee:

Agency Priority Goal 2: Empower communities to leverage EPA water infrastructure investments.

Agency Priority Goal 3: Accelerate the pace of cleanups and return sites to beneficial use in their communities.

The HSRP StRAP supports EPA's regulatory and non-regulatory programs by providing the best science, technical support, and guidance possible. Delivering research products to better protect human health

and the environment is HSRP's foremost goal. The science and research results that HSRP provides form the foundation for the environmental policies that are a precursor to achieving the best possible public and environmental health. Program, regional, state, federal, and tribal partners are HSRP's primary stakeholders and their needs will be used to determine HSRP core priorities. Therefore, the research outlined for the 2019–2022 time frame does indeed support Agency priorities as described in the EPA Strategic Plan and the HSRP StRAP.

The body of research planned and presented to the subcommittee advances the EPA and ORD strategic goals of advancing critical science to provide the American public clean air, clean water, and clean land by furthering the identification, remediation, and waste management phases of any cleanup effort whether biological, chemical, radiological, or nuclear.

EPA's collaborative federalism goal opens the door for further information sharing between ORD's HSRP, the federal government, states, and tribes. The research outlined for 2019–2022 has all the necessary components for ease of sharing with state, tribal, and local leaders. Additionally, EPA's roles in incident command per the National Biological Defense Strategy are clearly defined and serve as a basis for training experienced teams for effective response and remediation to protect the public in the event of chemical, biological, radiological, nuclear, and explosive (CBRNE) events. Listed below are specific strengths, suggestions, and recommendations.

**Strengths**

- HSRP has provided the critical science and research that has informed and supported the implementation of EPA's goals and strategy.
- HSRP conducts research that spans a continuum of time frames from longer-term forward-looking research to nearer-term research that both informs current Agency programs and responds to emergency situations. This continuum enables EPA to prepare for emerging environmental events.
- The Water on Wheel - Emergency Mobile Drinking Water Treatment System (the WOW water cart) addresses improved response time for impacted communities toward providing clean water for their population both during and after a crisis.
- HSRP's Oil Program is expanding lessons learned from Deepwater Horizon (DWH), coordinating with the National Oceanic and Atmospheric Administration (NOAA)'s initiatives, the U.S. Coast Guard (USCG), and other partners to use remote sensing, satellite images, and synoptic sampling to feed algorithms to determine oil thickness at oil spills, as opposed to prior human visual methods.
- The development of analytical tools—such as Waste Estimation Support Tool (WEST) for waste estimation, Remediation Data Repository (RADAR) for identifying critical remediation solutions, Environmental Sampling and Analytical Methods (ESAM) for identifying available sampling and analysis techniques, and the River Spill Tool for modeling contamination location—serve to place valuable information in the hands of incident commanders, decision-makers, and first responders directly achieving EPA Agency priority goal 2: accelerate the pace of cleanups and return sites to beneficial use.
- Global incidences and their response have provided HSRP with knowledge that can be extrapolated and interpolated into other similar or related events in the United States.
- HSRP has built partnerships with foreign governments to assist in foreign events, but more importantly to glean lessons learned to advance the U.S. knowledge base for similar incident management.

- Cooperative Research and Development Agreement (CRADA) partnerships open the door to collaborative and cost saving efforts for HSRP and will create valuable public/private partnerships to include the regulated community.
- HSRP has a highly motivated group of highly educated and intelligent scientists who significantly advance the body of scientific information given the resources available to them.

**Suggestions**

- The development of valuable tools to place in the hands of decision-makers in times of crises can only reach their full value through broad dissemination throughout the incident response community. HSRP should enhance this information sharing electronically, such as by posting on its public website.
- In the area of oil spill cleanup, the regulated community is currently conducting most of the spill cleanups across the country. The oil and gas industry has expertise in chemical characterization of domestically produced shale oils, fate and transport, and advanced remediation techniques including bioremediation. Is there a mechanism to bring this knowledge to HSRP? With the limited manpower and resources available to HSRP, this would be advantageous to support EPA's mission and priorities in this area.
- The EPA's collection of reference oils was lost during a previous storm. HSRP should obtain a collection of reference oils to continue relevant research.
- Develop further and test the scalability of analytical tools, including WEST for waste estimation, RADAR for identifying critical remediation solutions, and ESAM for identifying available sampling and analysis techniques.

## Recommendations

The subcommittee offers this recommendation to further advance the research outlined for the 2019–2022 time frame as it supports the relevant Agency priorities as described in the EPA and ORD Strategic Plans.

**Recommendation 1a.1:** Expand communication of HSRP's valuable research and spill response tools to state emergency response commissions (SERCs), local emergency planning committees (LEPC), and tribal emergency responders by maximizing the use of videos, webinars, white papers, staff participation in the SERCs, and the EPA's Smart Sectors Program.

*EPA Response: This is a timely and relevant comment, as state, local, territorial, and tribal (SLTT) engagement is a priority for EPA. The HSRP has developed a state engagement plan that is focused on engagement with SLTT organizations relevant to environmental emergency response. The HSRP will implement this recommendation with regard to the specific entities suggested to further advance the SLTT engagement strategy in FY20. The HSRP will work with EPA program and regional offices to determine the best way to engage the SERCs, LEPC, and tribal emergency responders as part of this strategy.*

## Charge Question 1b

Q.1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

**Narrative**

Core to EPA, ORD, and the HSRP vision and mission is serving the needs of its partners, including EPA offices, states, tribes, communities, the public, industry, international organizations, and other interested parties. Partners are served in multiple ways, such as through the Critical Infrastructure Partnership Advisory Council, which provides input and guidance to planning, testing, and implementing results for EPA's Water Security Test Bed. Through partnerships, the mission support for response is more successful, and stakeholders identify and use appropriate strategies developed within ORD. Lives are saved through access to the information and tools needed to respond to disasters. The proposed research program responds directly to the partner-identified needs. Listed below are specific strengths, suggestions, and recommendations.

**Strengths**

- HSRP addresses and engages its partners' needs and has developed a well-planned strategic priority list. An example of this plan includes the Analysis for Coastal Operational Resiliency (AnCOR) program, which addresses multiple agencies' concerns related to the characterization of agents, decontamination of watercraft, fate and transport, and waste management.
- HSRP regularly extends opportunities to engage end-users, such as through sessions with on-scene-coordinators, during which they provide an assessment of needs and product effectiveness. In May 2018, the program hosted the International Conference on Decontamination Research and Development, engaging both domestic and international stakeholders, with the goal of sharing findings and gaining insight into the needs of end-users.
- ORD has executed agreements with stakeholder organizations such as the National Environmental Health Association, the Association of State and Territorial Health Officials, and the Critical Infrastructure Protection Advisory Committee to gain insight into research needs of stakeholders represented by these organizations.
- A need identified through interaction with partners includes HSRP's ESAM tool. This online resource is an excellent example of a publicly available tool used to support response to threats and releases.

**Suggestions**

- HSRP should consider expanding engagement with state, county, and local responders to include citizens and stakeholder organizations (e.g., real estate, homeowners' associations, banks, and insurance industry groups) for input. Citizens can provide a valuable source of data to increase the early notification of potential releases or threats (e.g., "if you see something, say something").
- While the HSRP has developed a seemingly successful tool in ESAM for sample collection and analysis, it should contemplate providing a tool for citizen decontamination and response actions appropriate to a known hazard to reduce exposure. HSRP should also develop a strategy to incorporate engagement with local and county level emergency responders to expand the use of tools and resources, examine use of computer-based training platforms, and use train-the-trainer programs to build capacity.
- HSRP should consider controls to research waste and decontamination at the Idaho National Laboratory (INL) field testing water system lagoon because it is an outdoor lagoon and susceptible to windblown debris and runoff.
- The program should expand collaboration attempts to engage cyber experts when conducting research into critical software operating and supervisory control and data acquisition systems. HSRP should also consider the interface potential with the plume modeling tools under

development with existing platforms such as Cameo, Marplot, and Aloha and other packages that these entities already use.

## Recommendations

The subcommittee offers these two recommendations to address partner-identified needs.

**Recommendation 1b.1:** Expand the water research portfolio (i.e., decontamination) to include materials other than ductile iron and concrete-lined piping (e.g., PVC, CPVC, Transite, and tree trunks), and develop a strategy to study emergent materials.

*EPA Response: HSRP is currently conducting bench, pilot, and full-scale decontamination research on other pipe materials such as PVC, which is found in distribution systems and home plumbing, and materials like copper and cross-linked polyethylene (PEX), which are found only in home plumbing. In addition, HSRP proposes to seek stakeholder input (e.g. through AWWA, WEF, and/or the CIPAC) on other widely used, vulnerable, or critical infrastructure materials, and incorporate these materials into EPA's full-scale Water Security Test Bed. HSRP will prioritize conducting research on other pipe materials based upon stakeholder input and how common those pipe materials are in distribution systems and home plumbing (with more common materials taking precedence). Specific materials can be prioritized higher if indicated in certain threat scenarios.*

**Recommendation 1b.2:** Adapt mobile platforms for tools to apps for future users (next generations). HSRP should incorporate a means by which product updates, new versions of guidance, and changes to existing topic areas could be emailed to users of electronic tools (for which users could opt in).

*Response: Many HSRP tools in their current form are already accessible on mobile devices - even if not a mobile app. Tools are also hosted on Github (e.g. EPANET Real-time Extension, Water Network Tool for Resilience) and are available to the public for further development. HSRP proposes to evaluate which tools might benefit from being on a mobile platform based upon intended user/stakeholder and their use of the tool. Some tools are meant for reach-back support, while others may be useful to field responders on-site. HSRP, with customer/stakeholder input, proposes to develop a comprehensive plan for tool development, including mobile platforms, and continued integration as appropriate. This plan will consider all tools (existing and new) and the path forward for ownership, maintenance, and platform, while taking into consideration resource constraints.*

## Charge Question 1c

Q.1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

**Narrative**

HSRP StRAP topics, research areas, and outputs are clearly aligned with the strategic vision of the program. HSRP works in coordination with its partners and stakeholders to effectively conduct research that provides decision-makers information needed for their communities and environments to rapidly recover

after a known disaster. The environmental problems that HSRP is addressing are diverse and subject to emerging issues that may change priorities and detract from some focused activities.

StRAP research topics include 1) Contaminant characterization and consequence assessment, 2) Environmental cleanup and infrastructure remediation, and 3) Systems approaches to preparedness and response.

Research areas associated with contaminant characterization and consequence assessment include contaminant fate and transport; exposure and contaminant detection; and environmental sampling and analysis. Environmental cleanup and infrastructure remediation research areas include wide-area decontamination, water treatment and infrastructure decontamination, oil spill response support, and waste management. Further development of tools to support systems-based decisions is aligned with the systems approaches to preparedness and response. Research activities are solutions-driven and applied broadly across ORD's six national research programs, and include pilot translational science projects and case studies of previous and current research to develop and implement best practices for addressing wide-area contamination and prevent, prepare, and respond to water contamination impacting public health.

Proposed outputs for the HSRP are quite ambitious with 36 identified outputs prioritized by fiscal year through FY2022. HSRP has identified five outputs associated with fate, transport and exposure, including disseminating provisional advisory levels for high-priority chemical contaminants and determining cleanup goals for chemical warfare agents and their degradants in FY2020. An additional five outputs are included in the HSRP plan associated with detection/environmental sampling and analysis, six outputs are associated with wide-area contamination, six outputs are related to water treatment and infrastructure decontamination, five outputs are associated with oil spill response support, four outputs are related to waste management, and four additional outputs are for development of tools to support system-based decisions. Development of a database for data on remediation for all-hazards response and recovery research, operations, and tools is scheduled for FY2019. Listed below are specific strengths, suggestions, and recommendations.

**Strengths**

- HSRP is composed of an outstanding, committed, multidisciplinary research team.
- Research is solution or outcome-driven.
- Effective applied research projects are designed to address needs of stakeholders.
- Subject matter experts (SMEs) are engaged as needed to address problems as they arise.
- Research priorities/activities are developed through engagement with stakeholders.
- Best practices are incorporated in communicating risk to stakeholders and the public.
- ESAM online tool is an example of an effective tool developed by the HSRP to guide sampling and analysis associated with an event.
- Application of the CRADA model is beneficial in addressing identified research gaps.
- Research findings are summarized in fact sheets and "one pagers" for emergency responders and on-scene coordinators.
- Key research findings are published in reports and peer-reviewed journals.

**Suggestions**

- Partner with other EPA labs (e.g., National Exposure Research Laboratory [NERL], Jon Sobus, Mark Strynar), the National Institute of Environmental Health Sciences (NIEHS; David Balshaw), and

agencies like the Federal Bureau of Investigation (FBI) to keep abreast of emerging methods for identification of chemical or other unknowns and to determine when those capabilities can be accessed through partnership or when the resource needs to be developed within the HSRP.

- Use whole genome sequencing technology where appropriate, e.g., biological agents.
- Maintain relationships with partners such as the Centers for Disease Control and Prevention (CDC) to develop strategies to respond to emerging and reemerging diseases.
- Monitor and develop strategies to respond to public health threats resulting from extreme weather events, hurricanes, tornadoes, flooding, wild fires, etc.
- Develop template and online process to collect and report data effectively and rapidly to stakeholders.
- Work with other federal agencies with laboratory response networks (e.g., CDC LRN) to ensure that data are reported promptly and in a format to rapidly produce and provide risk communication information to stakeholders.
- Temper timeline and outputs, which may be overly ambitious given ongoing response needs of stakeholders.
- Assess current capabilities and capacity to respond to a radiochemical event. Analytes are known and analytical methods are relatively well developed, but laboratory expertise and capacity are diminishing, particularly at the the state level.

## Recommendations

The subcommittee offers these two recommendations to further address research areas and proposed outputs.

**Recommendation 1c.1:** Further develop screening methods to rapidly identify and characterize "chemical unknown(s)" from contamination events.

*EPA Response: EPA's experience in real-world situations has been that our cleanup response generally begins after the contaminant is already identified or known via law enforcement and public health investigations. For cleanup purposes, the extent and amount of contaminants are usually the critical information needs for a successful response. HSRP will continue to advance methods (e.g., methods in ESAM) for sampling/analysis of all classes on contaminants. We also note that HSRP has access to the RACER support network within ORD, where we have immediate access to the expertise of ORD's exposure experts, such as the Non-Targeted Methods research that ORD is advancing to identify unknown contaminants in environmental matrices in the absence of laboratory standards (e.g., PFAS variants).*

**Recommendation 1c.2:** Further establish means to isolate, decontaminate, and purge sections of drinking water distribution systems to limit and mitigate deliberate or accidental chemical, biological, radiological, and nuclear (CBRN) contamination events.

*EPA Response: HSRP will address this area in three ways. First, research on isolation of CBRN in distribution systems is being conducted using hydraulic modeling tools developed by HSRP. These tools are well developed and mature, and HSRP's current focus is on conducting case studies to determine how the tools perform using hydraulic models of real distribution systems. Second, bench, pilot, and full-scale drinking water infrastructure decontamination research is ongoing and will address multiple CBRN contaminants in the coming years. Finally, purging contamination from distribution systems is being addressed through*

*research on full-scale treatment of large volumes of contaminated water, and waste management research focused on disposal of contaminated water.*

## Charge Question 1d

Q.1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

**Narrative**

As the scientific research arm of the EPA, ORD's HSRP can advance the field through its own research, and serve as a force multiplier, leveraging the research of others through expertise, partnership, collaboration, incubation, facility and technique sharing, funding, and many other entrepreneurial techniques. Much like the negative human and environmental health consequences of increased atmospheric carbon dioxide that were not as well understood 30 years ago as they are today, there are likely other adverse environmental developments unknown at this point. Therefore, HSRP must be positioned to assist in the discovery of such issues and to advance solutions. While fiscal stewardship within any governmental organization is critical, cutting edge science and advancing knowledge requires strategic investment. ORD must invest resources and scientific personnel into advancing the science within its established research areas and advance scientific questions that push the field and knowledge base forward so that it better protects the environment and the health of all. Listed below are specific strengths, suggestions, and recommendations.

**Strengths**

- HSRP's existing research plans are strengths from both a scientific personnel and scientific infrastructure perspective; of particular note is the unique capabilities of the Water Security Test Bed at INL. The Test Bed is a singular facility within the United States that gives HSRP the ability to respond to emergent needs influencing the countries water infrastructure.
- Each area within HSRP has been very entrepreneurial in leveraging its relatively small budget and personnel numbers through collaboration and partnerships with other governmental partners. An operating principle of the organization is to build partnerships with entities that have complementary expertise. This allows the reduction of governmental duplication and gives all parties the flexibility to address emerging issues and/or expertise needs.
- HSRP's bio-decontamination focus on the spore-forming *Bacillus anthracis* (BA) and surrogate organisms is an excellent approach. Determining how to decontaminate this environmentally hardy organism can inform methods to handle less environmentally hardy organisms, including emerging pathogens yet to be identified.
- HSRP's work associated with large area decontamination takes a broad approach; particularly of note has been its focus on usability and adaptation of off-the-shelf products for novel decontamination applications (e.g., wet vacuums). By remaining open to off-the-shelf options and problem-based solutions relating to emerging needs, HSRP achieves organizational flexibility and greater operational capacity.
- In both staffing and strategy, HSRP has recognized that human elements influence the successful development and implementation of scientific and technological solutions to the problems of

wide-area and water contamination incidents—from engaging diverse partners to scope issues to communicating risk and its management in meaningful terms (e.g., 3-D City for visualizing fate/transport) so that the public has a full grasp of, and faith in, the technical solutions.

- Cybersecurity is a compelling emerging concern. HSRP has done due diligence in exploring whether its partners and customers need scientific research support within this area. For example, it convened a workshop with SMEs to identify cybersecurity risks, gaps, and needs. At this point, HSRP has rightfully determined that other organizations are better suited and more aligned with expertise and resources to address this emerging issue.
- The integration of oil spill issues into the HSRP portfolio provides for greater synergy and advances across the board. This organizational shift allows for greater flexibility in addressing emerging concerns, and in particular those in partnership with USCG.

**Suggestions**

- Preserve current workforce capacity and reconfigure existing program initiatives to address emergent priority needs. For instance,
  - Create deliberate plans for the succession and the continuation of projects and expertise as individuals depart or retire, given HSRP's heavy reliance on a small number of individuals;
  - Leverage the resident social scientist's connections with the larger community of social and behavioral scientists across the six ORD programs and within EPA, and feature a full community resilience panel at future decontamination conferences.
  - Seize the rare research opportunities enabled by a full-scale, resource-intense field test (e.g., AnCOR) to integrate a socio-behavioral component at the outset e.g., Coast Guard personnel perceptions of clean up and re-entry.
- Weigh potential resource investments in research topics related to critical environmental developments (e.g., changing climate, oil drilling in the arctic region, complex exposures). For instance,
  - Expand HSRP focus and modeling to more mixtures, degradation products, and different exposure variables because emerging threats are increasingly more complex (e.g., post-9/11 air quality affected by multiple degradation products tied to burning building).
  - Consider climate-related interactions. As predicted sea level rise continues, the coastal areas will have greater significance as near-shore pollutants move from the riparian or coastal soil environments into water bodies.
  - More thoroughly integrate waste management and oil spill response support within the HSRP research portfolio. For example, in distinct environments (i.e., gulf coast versus the arctic), different operational challenges may arise for waste management, or oil dispersants and other compounds could have different ecological impacts.
- Leverage partnerships to stretch scarce resources and create synergy to meet emergent needs. For instance,
  - Work with Air Force Research Lab on materials compatibility with decontamination processes. NIEHS' Worker Training Program (WTP) has a robust program of training works in the field to address issues associated with CBRN events.
  - Collaborate with the Department of Agriculture, Occupational Safety and Health Administration, and commodities groups on decontamination and issues associated with mass depopulation of animal agriculture and the waste management of a large volume of contaminated animal biomass.
  - Collaborate with the Department of Transportation on the science of transporting Category A Waste. More scientific research associated with emerging and reemerging pathogen issues

on a large scale could benefit current recommendations for the packaging for transport of Category A Waste.

### Recommendations

The subcommittee offers this recommendation to address critical emerging environmental needs in a cost-effective manner.

**Recommendation 1d.1:** Develop a cross-cutting matrix of subject matter expertise that can be applied toward any novel issue. What urgent issues have yet to surface are uncertain; what is certain, however, is the wide-ranging expertise that HSRP now commands and could apply to a newly emergent threat or exigent situation.

*EPA Response: Currently, ORD has an existing employee expertise database and ORD researchers self-report expertise through the research planning process and other efforts. This ORD database and efforts could be leveraged to develop a cross-cutting matrix of subject matter expertise to prepare for any novel issue. HSRP will work with rest of ORD to explore how these existing information streams and systems could be expanded and tailored to this need. We also note that the Reachback for Emergency Response (RACER) system is operative in ORD to provide ready access to all of ORD's technical resources during an environmental incident.*

## Charge Question 1e

Q.1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

**Narrative**

The subcommittee sees significant opportunities for HSRP to increase the impact of its limited financial and human resources by leveraging market-oriented innovation and problem-solving resources. Listed below are specific strengths, suggestions, and recommendations.

**Strengths**

- HSRP's innovativeness, capabilities, and productivity benefit from collaborating with other organizations.
- Employing interns can reduce labor costs while increasing access to latest technologies (e.g., via students already trained in the latest software tool development methods).
- Development of the WOW Cart demonstrated that a CRADA, which protects the cooperator's intellectual property investment, can produce an innovative product with commercial potential at minimal cost (to the EPA).
- The EPA offers challenges and prizes "to find solutions by tapping into the ingenuity and creativity of crowds" (https://www.epa.gov/innovation/challenges-prizes).
- The EPA collaborates with organizations, such as the Water Research Foundation (WRF), to guide funding to qualified researchers to work on specific problems. WRF recently sponsored a well-

subscribed challenge (http://www.werf.org/LIFT/IWSChallenge2018) that offered no prize other than publicity and "fame and glory" to the winners.

**Suggestions**

- Investigate options for crowdsourcing R&D with organizations like WRF that have interests in common with HSRP. Investigate companies that facilitate crowdsourcing innovative solutions to problems. For example, Innocentive (https://www.innocentive.com/) facilitates internal challenges to an organization's staff and external challenges to Innocentive's network of over 380,000 problem solvers (https://en.wikipedia.org/wiki/InnoCentive). Internal challenges further leverage the talents of already attuned employees. Problem solver networks like Innocentive's would provide the National Homeland Security Research Center (NHSRC) with new sources of expertise, fresh ideas, inventiveness, and short- and long-term partnering opportunities, possibly via CRADAs. "Red-team/blue-team" challenges could meet pathfinding and horizon-scanning goals.
- Reorganize HSRP's software development and maintenance activities to leverage ready and willing experts through non-traditional contracting, such as prizes, challenges, and CRADAs, which could yield significant improvements in speed, quality, and cost. Software development and the maintenance of legacy applications can be more time consuming and expensive when performed within layered organizations like the EPA for whom such activities are not a core competency.
- Reach out to other agencies for leveraging opportunities, e.g., the oil spill research program works closely with the USCG and NOAA.

## Recommendations

The subcommittee offers these two recommendations for boosting innovation and employing market-based approaches that the program could use to advance solutions to existing and emerging environmental problems.

**Recommendation 1e.1:** Create an integrated plan for establishing an internal Innovation Council, reaching out to other agencies for interagency leveraging opportunities, and employing external crowdsourcing.

*EPA Response: HSRP highly values innovation and creativity. HSRP engaged the 'NHSRC innovation team' (now incorporated into the new Center for Environmental Solutions and Emergency Response (CESER)) that promoted innovative research approaches. This Innovation Team led internal challenges in the past where researchers were encouraged to submit proposals for funding of a cutting-edge idea to meet some of the HSRP's more difficult research gaps. This provided the awardees of the challenge with a small amount of funding to help them develop and test a proof of concept idea that could then be mainstreamed into the research program as justified via the initial results. Further, NHSRC/CESER researchers have submitted proposals to some of ORD's Innovation Challenges, including Pathfinder Innovation Proposals (PIPs), and worked with EPA Regional Office staff to submit RARE proposals for developing and testing innovative ideas to meet challenging regional needs. NHSRC/CESER researchers have sought interagency partnerships to collaboratively develop and test novel ideas. One example includes partnership with DHS to develop automated cleaning robots as sampling devices for B. anthracis environmental contamination incidents. HSRP will seek to re-vamp the NHSRC/CESER Innovation Team and charge them for outreach and collaboration opportunities for research and tool development. HSRP will also continue to engage with cross-ORD open innovation/prize activities, where ORD, working through the innovation team in OSAPE, will be preparing an ORD open innovation/challenge strategy in 2020 to more broadly coordinate ORD's activities and resources.*

**Recommendation 1e.2:** Conduct two major internal challenges: a "hardware challenge" and a "software challenge" to advance one or more of the NHSRC's early stage concepts or inventions. These internal challenges with a modest prize could incentivize EPA employees to innovate and/or accelerate projects.

*EPA Response: We agree that promoting innovation through incentives via hardware and software challenges are excellent ideas. HSRP will provide these recommended challenges to the CESER Innovation Team for further development. In addition, the HSRP will seek hardware and software development through the Small Business Innovation Research program, and actively participate and respond to the above-noted planned ORD open innovation strategy.*

## Charge Question 2

Q.2. Homeland Security Research is designed to address known threats and vulnerabilities. At the same time, the Nation regularly faces unforeseen challenges in public health and the environment (e.g., Ebola and Zika viruses, opioid misuse). Please comment on the extent to which the Program's design enables use of its scientific contributions in also addressing unforeseen needs of the EPA programs and regions, states, and tribes. How can HSRP improve its applicability to unanticipated urgent threats?

**Narrative**

The StRAP proposes to continue HSRP's longstanding mission focus on specific products and outcomes developed in close coordination with its customers. A potential consequence of a highly focused research program like this is the development of capabilities and products that perform exceptionally well for a set of specific needs (an essential outcome), but may or not be more broadly useful for addressing a different set of "unforeseen" needs. Charge Question 2 asks whether the research and research plan are suitable for or can be adapted to respond to events or threats that fall outside the known threat space. To address this question, the subcommittee considered the HSRP in the context of some characteristics of a highly adaptable research plan.

Characteristics of such an agile and adaptable program might include: (i) capabilities and expertise in fundamental physical, chemical, environmental, and biological processes applicable to a very broad set of threats; (ii) decision tools that allow identification of the unique/non-unique aspects of the unforeseen threat; (iii) adaptable technical tools; (iv) sampling, decontamination, waste management, and modeling tools for all environmental media (air, water, soil, built environment), and for broad chemical, radiological, and biological agent classes; and (v) strong partnerships with other organizations with expertise that can be leveraged (e.g., CDC).

The subcommittee also considered the nature of unforeseen threats of consequence that would test the limitations and adaptability of a research program. These included but are not limited to: (i) unusual properties: biological or chemical agents with longer environmental half-lives, unusually rapid environmental transport (MTBE), or physicochemical properties that make it resistant to standard cleanup (soap, solvents, water, disinfectant, etc.); and (ii) new environments and interactions: terrestrial-aquatic interface and artic environment.

The subcommittee has identified elements of the HSRP that aligned with and promoted adaptability to unforeseen threats (strengths) and opportunities to build on existing strengths to significantly increase flexibility and adaptability (suggestions). The most impactful suggestions were proposed as recommendations. Listed below are specific strengths, suggestions, and recommendations.

**Strengths**

- The ability to adapt and apply its research to meet unforeseen challenges in a timely manner is specified as a priority in the StRAP.
- Embracing computation and modeling maximizes the utility and applicability of data to new threats through simulation and extrapolation.
- HSRP's systems approach to decision-making produces expertise and tools with greater flexibility and applicability to imagined or real scenarios outside of the traditional threat space. RADAR and WEST are good examples of flexible tools emerging from a systems approach.
- HSRP reduces the scope of unforeseen threats, and increases time to respond through ties to agencies with responsibility for CBRN Horizon Scanning.
- Close coordination with customers' guides produces flexible solutions designed for the flexibility to serve multiple scenarios. The self-contained, portable water purifier is an excellent example.
- HSRP uses tools and knowledge developed for one purpose to address stakeholder questions for an unexpected threat (e.g., with Ebola).
- HSRP robotic platforms for sampling are an example of flexible platforms applicable to multiple scenarios.

**Suggestions**

- Detail or integrate HSRP staff with interagency intelligence teams/fusion centers to speed and extend identification of emerging threats. Involvement in the emerging biodefense plan should be pursued. Unclassified distillations of classified reports are a likely deliverable to EPA and should still contain useful information regarding the nature of emerging threats (chemical space, property of concern, etc.).
- Initiate a workshop or similar event with other agencies to create three to six scenarios that might represent important aspects of the scope of "unforeseen threats." Base scenario on functional characteristics rather than on specific agents. Formally evaluate the HSRP's adaptability/relevance in the context of the how it would perform in these scenarios. Revise the HSRP.
- Create a matrix of methods for sampling, decontamination, and analysis for persistent chemical, biological, radiological (CBR) agents. Identify gaps in these methodologies for important classes of compounds.
- Determine how existing HSRP products could be used or modified to address potential emerging threats. Expand efforts to produce new knowledge/data that enable interpolation and extrapolation of tools/approaches by selecting test agents/systems that over time expand the chemical/systems space or knowledge/tools in which data exist. Some focus on worst-case systems (e.g., BA spores, long half-life chemicals), in which resources are too limited, will continue to be the best way to meet the need of extrapolating conservatively.
- Expand interactions with stakeholders (citizen groups, infrastructure groups, state emergency response teams, associations) and include new stakeholders to identify new scenarios and find support for pilot and field demonstrations.

### Recommendations

The subcommittee offers these two recommendations to capitalize on how HSRP can improve its applicability to unanticipated urgent threats.

**Recommendation 2.1:** Refine or define what would constitute an unforeseen event that would fall outside current capabilities (outside of chemical space, biological space, environmental space) in order to identify and prioritize data gaps for research over the course of 3-5-10 years.

*EPA Response: HSRP will continue to improve the response capabilities of known threats (natural, accidental, and traditional terrorist tactics). HSRP proposes to regularly define and assess the potential unforeseen events that may become actual threats with stakeholders during the research needs/gaps assessment and to prioritize the identified gaps. HSRP will engage its customers/stakeholders, including CBRN horizon scanning Federal agencies, to discuss defining what would constitute an unforeseen event and look for signals and timelines informed by the stage of development of emerging threats in the open and classified literature. This assessment will include evaluation of the potential emerging enabling technologies, such as synthetic biology, computer-aided chemical engineering, and cybersecurity. Emerging technologies could result in unforeseen or catastrophic environmental contamination.*

**Recommendation 2.2:** Engage and leverage CBRN horizon-scanning agencies to increase knowledge about potentially emerging threats, particularly in the rapidly changing biothreat and chemical threat space. Frame in the context of Recommendation 2.1.

*EPA Response: HSRP will continue engagement with EPA program offices and CBRN horizon scanning Federal agencies to foster better communication of emerging threats and facilitate collaborative research on environmental data gaps. This engagement will focus on collaboration with EPA's Office of Homeland Security to learn the available threat streams that track relevant environmental threats; sharing EPA research to inform threat assessments and horizon-scanning agencies through active participation in various format such as tabletops, conferences, and workgroups; and collaborative research to fill data gaps associated with emerging threats and mitigate against Black Swan events.*

## SUMMARY LIST OF RECOMMENDATIONS

This section provides a listing in a single location of the recommendations provided earlier in the report in response to each charge question.

### Charge Question 1a. Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

- **Recommendation 1a.1:** Expand communication of HSRP's valuable research and spill response tools to state emergency response commissions (SERCs), local emergency planning committees (LEPC), and tribal emergency responders by maximizing the use of videos, webinars, white papers, staff participation in the SERCs, and the EPA's Smart Sectors Program.

Charge Question 1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

- **Recommendation 1b.1**: Expand the water research portfolio (i.e., decontamination) to include materials other than ductile iron and concrete-lined piping (e.g., PVC, CPVC, Transite, and tree trunks), and develop a strategy to study emergent materials.
- **Recommendation 1b.2**: Adapt mobile platforms for tools to apps for future users (next generations). HSRP should incorporate a means by which product updates, new versions of guidance, and changes to existing topic areas could be emailed to users of electronic tools (for which users could opt in).

Charge Question 1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

- **Recommendation 1c.1**: Further develop screening methods to rapidly identify and characterize "chemical unknown(s)" from contamination events.
- **Recommendation 1c.2**: Further establish means to isolate, decontaminate, and purge sections of drinking water distribution systems to limit and mitigate deliberate or accidental chemical, biological, radiological, and nuclear (CBRN) contamination events.

Charge Question 1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

- **Recommendation 1d.1**: Develop a cross-cutting matrix of subject matter expertise that can be applied toward any novel issue. What urgent issues have yet to surface are uncertain; what is certain, however, is the wide-ranging expertise that HSRP now commands and could apply to a newly emergent threat or exigent situation.

Charge Question 1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

- **Recommendation 1e.1**: Create an integrated plan for establishing an internal Innovation Council, reaching out to other agencies for interagency leveraging opportunities, and employing external crowdsourcing.
- **Recommendation 1e.2:** Conduct two major internal challenges: a "hardware challenge" and a "software challenge" to advance one or more of the NHSRC's early stage concepts or inventions. These internal challenges with a modest prize could incentivize EPA employees to innovate and/or accelerate projects.

Charge Question 2: (Homeland Security Subcommittee-specific): Homeland Security Research is designed to address known threats and vulnerabilities. At the same time, the Nation regularly faces unforeseen challenges in public health and the environment (e.g., Ebola and Zika viruses, opioid misuse). Please comment on the extent to which the Program's design enables use of its scientific contributions in also addressing unforeseen needs of the EPA programs and regions, states, and tribes. How can HSRP improve its applicability to unanticipated urgent threats?

- **Recommendation 2.1**: Refine or define what would constitute an unforeseen event that would fall outside current capabilities (outside of chemical space, biological space, environmental space) in order to identify and prioritize data gaps for research over the course of 3-5-10 years.
- **Recommendation 2.2**: Engage and leverage CBRN horizon-scanning agencies to increase knowledge about potentially emerging threats, particularly in the rapidly changing biothreat and chemical threat space. Frame in the context of Recommendation 2.1.

## CONCLUSIONS

The BOSC HSRP subcommittee was charged with reviewing and providing input on the draft 2019–2022 StRAP documents and proposed research strategies. The emphasis is on advancing ORD research that can successfully address the needs identified by EPA programs and regions, states, and tribes. The HSRP subcommittee reviewed the HSRP research over three days in December 2018. The overarching issue addressed by the committee was, Is HSRP doing the right research? In other words, how well does the HSRP's current research portfolio address high-priority Agency needs in this area? Taking resource limitations into consideration, should the HSRP increase or decrease the emphasis of certain areas of research?

The subcommittee determined during the review that the HSRP's research is aligned with the StRAP and is poised to deliver research necessary to support EPA's overall mission to protect human health and the environment, fulfill the EPA's legislative mandates, and advance cross-agency priorities identified in the FY2018–FY2022 EPA Strategic Plan. HSRP has demonstrated many significant strengths and outputs. The subcommittee has identified suggestions and recommendations that can further improve HSRP's research efforts in meeting key stakeholder and Agency needs. This review by the BOSC HSRP subcommittee of the draft HSRP StRAP will be followed by regular BOSC reviews of research activities over the course of the StRAP implementation.

# APPENDIX A: MEETING AGENDA

| **Wednesday, December 12, 2018<br>EPA-RTP Main Building Room D101** | | | |
|---|---|---|---|
| **Time** | **Topic** | **Presenter** | **Description** |
| 8:00 | Registration | | |
| 8:30 | BOSC Introduction | Tom Tracy, EPA Designated Federal Official<br>Bruce Rodan, ORD DAA for Science<br>Paula Olsiewski, Chair<br>Lance Brooks, Vice-Chair | • Introductions of the Subcommittee and EPA participants<br>• BOSC and FACA rules review<br>• Logistics<br>• Agenda |
| 8:50 | HS Research Program Foundation and Purpose | Greg Sayles | • HS research priorities supporting EPA Strategic Plan<br>• EPA HS roles/responsibilities<br>• Coordination with federal, state, and local customers<br>• Scenario examples |
| 9:30 | HS Research Program Design | Shawn Ryan | • Customer engagement and customer-driven research<br>• Program organization<br>• General research approach<br>• Unanticipated and emerging needs |
| 9:50 | Break | | |
| 10:00 | Review Charge Questions | Romy Campisano | • Review and clarification of charge questions |
| 10:20 | **Research Area Overview:** Contaminant, Fate, Transport and Exposure | Paul Lemieux | • Summary of research needs<br>• General research planned to meet needs, including expertise involved, specialized facilities/equipment used, and novel/innovative methods developed<br>• Research example(s) |
| 10:40 | Travel to EPA Fluid Modelling Facility | | |
| 10:50 | Research Area Demo | Paul Lemieux<br>Tim Boe | • 3D city for fate/transport and visualization<br>• Rainfall simulator and field work at Edison |

| | | | |
|---|---|---|---|
| | | Anne Mikelonis | |
| 11:40 | Travel to EPA Main Campus | | |
| 12:00 | Lunch Break | | |
| 12:45 | **Research Area Overview:** Contaminant Detection/Environmental Sampling and Analysis | Sarah Taft | • Summary of research needs<br>• General research planned to meet needs, including expertise involved, specialized facilities/equipment used, and novel/innovative methods developed<br>• Research example(s) |
| 13:00 | Travel to Aerosol Test Facility | | |
| 13:15 | Research Area Demo | Sang Don Lee<br>Worth Calfee<br>John Archer<br>Vince Gallardo | • Innovative sampling approaches<br>• Application to wide area response<br>• Activity-based air sampling<br>• Water sampling and processing |
| 14:00 | Break | | |
| 14:15 | **Research Area Overview:** Wide Area Decontamination | Sang Don Lee | • Summary of research needs<br>• General research planned to meet needs, including expertise involved, specialized facilities/equipment used, and novel/innovative methods developed<br>• Research example(s) |
| 14:30 | Travel to High Bay | | |
| 14:45 | Research Area Demo | Sang Don Lee<br>Lukas Oudejans<br>Joe Wood<br>Worth Calfee | • Introduction<br>• Bench-scale decontamination testing<br>• Bench to pilot scale decontamination testing<br>• Application to wide area decontamination |
| 15:15 | Travel to Conference Room | | |
| 15:30 | Daily Wrap-up/Questions | | |
| 16:00 | BOSC Subcommittee work time | | |

| **Thursday, December 13, 2018**<br>**EPA-RTP Main Building Room D101** | | | |
|---|---|---|---|
| **Time** | **Topic** | **Presenter** | **Description** |
| 8:30 | Questions from Day 1 | | |
| 9:00 | **Research Area Overview:**<br>Oil Spill Research | Robyn Conmy | • Summary of research needs<br>• General research planned to meet needs, including expertise involved, specialized facilities/equipment used, and novel/innovative methods developed<br>• Research example(s) |
| 9:45 | **Research Area Overview:**<br>Water Treatment and Infrastructure Decontamination | Kelly Dipolt | • Summary of research needs<br>• General research planned to meet needs, including expertise involved, specialized facilities/equipment used, and novel/innovative methods developed<br>• Research example(s) |
| 10:00 | Research Area Demo: *Water Security Test Bed Video* | Jeff Szabo | EPA's Water Security Test Bed, full-scale studies of contaminated water infrastructure and treatment. |
| 10:30 | Break | | |
| 10:45 | **Research Area Overview:**<br>Waste Management | Emily Snyder | • Summary of research needs<br>• General research planned to meet needs, including expertise involved, specialized facilities/equipment used, and novel/innovative methods developed<br>• Research example(s) |
| 11:15 | Research Area Demo: On-Site Water Treatment Cart | Jim Goodrich | |
| 11:30 | Future Field-Scale Study and Demonstration (AnCOR) | Shawn Ryan | |
| 11:45 | Lunch | | |
| 12:30 | **Research Area Overview:**<br>Introduction to Tools | Kelly Dipolt | • Summary of research needs<br>• Explanation of Tools Demonstration |
| 12:45 | Tools Demonstrations<br>EPA-RTP Rooms C-500A and C-500C | Paul Lemieux<br>Tim Boe<br>Sarah Taft<br>Jim Goodrich | • WEST<br>• RADAR<br>• ESAM<br>• River Spill Tool |

| | | | |
|---|---|---|---|
| 13:45 | **Research Area Overview:**<br>Future of Systems-Based Decision Support Tools | Kelly Dipolt | Systems-approach to decision support tool development |
| 14:15 | Break | | |
| 14:30 | BOSC Subcommittee work time | | |
| 16:30 | Daily Wrap-up/Questions | | |
| | | | |

| **Friday, December 14, 2018**<br>**EPA-RTP Main Building Room D101** | | | |
|---|---|---|---|
| **Time** | **Topic** | **Presenter** | **Description** |
| 8:30 | Anticipated Accomplishments | Shawn Ryan | Highlight anticipated accomplishments |
| 9:00 | Public Comment | Tom Tracy | |
| 9:15 | Wrap-up/Questions | Tom Tracy | |
| 9:30 | BOSC Subcommittee work time | | |
| 11:30 | Follow-up Question Session | Greg Sayles<br>Shawn Ryan | |
| 12:00 | Adjourn | | |

# APPENDIX B: MATERIALS

## Material Provided in Advance of the Meeting

***Materials to Support the Charge Questions***

- Agenda
- Charge questions
- Pre-meeting notes
- Pre-meeting teleconference slides
- Draft HSRP StRAP (External Review Draft, November 15, 2018 version)
- EPA Strategic Plan https://www.epa.gov/planandbudget/strategicplan
- ORD Strategic Plan

## Additional Material Provided During the Meeting

- BOSC HS subcommittee roster

BOSC

BOARD OF SCIENTIFIC COUNSELORS

# REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

## BOSC SAFE AND SUSTAINABLE WATER RESOURCES SUBCOMMITTEE


Joseph Rodricks, Ph.D., DABT (Chair)
*Ramboll Environ*

Robert Blanz, Ph.D., PE (Vice Chair)
*Arkansas Department of Environmental Quality*

Scott Ahlstrom, PE, PMP
*Corix Utilities*

Jerad Bales, Ph.D., MS
*Consortium of Universities for the Advancement of Hydrologic Science, Inc.*

Elizabeth Boyer, Ph.D., MS
*Penn State University*

Steve Carr, Ph.D.
*Los Angeles County Sanitation Districts*

Shahid Chaudhry, MSc
*California Energy Commission*

David Cole, MS
*Oregon Department of Environmental Quality*

Timothy Davis, Ph.D.
*Bowling Green State University*

Joel Ducoste, Ph.D., BCEEM
*North Carolina State University*

Elizabeth Fassman-Beck, Ph.D., MSc
*Stevens Institute of Technology*

Fred Hitzhusen, Ph.D.
*The Ohio State University, retired*

Lucinda Johnson, Ph.D.
*University of Minnesota Duluth's Natural Resources Research Institute*

Kate Lajtha, Ph.D.
*Oregon State University*

Michelle Lorah, Ph.D.
*U.S. Geological Survey*

John Lowenthal, MS, PWS, PWD
*Cardno*

Tim Verslycke, Ph.D.
*Gradient*

Stephen Weisberg, Ph.D.
*Southern California Coastal Water Research Project Authority*

John White, Ph.D.
*Louisiana State University*


EPA Contact
**Tom Tracy, Designated Federal Officer**

August 19, 2019

Disclaimer Text. This report was written by the Safe and Sustainable Water Resources (SSWR) subcommittee of the Board of Scientific Counselors, a public advisory committee chartered under the Federal Advisory Committee Act (FACA) that provides external advice, information, and recommendations to the Office of Research and Development (ORD). This report has not been reviewed for approval by the U.S. Environmental Protection Agency (EPA), and therefore, the report's contents and recommendations do not necessarily represent the views and policies of EPA, or other agencies of the federal government. Further, the content of this report does not represent information approved or disseminated by EPA, and, consequently, it is not subject to EPA's Data Quality Guidelines. Mention of trade names or commercial products does not constitute a recommendation for use. Reports of the Board of Scientific Counselors are posted on the Internet at http://www.epa.gov/bosc.

# CONTENTS

**LIST OF ACRONYMS** ..... **D-4**

**INTRODUCTION** ..... **D-5**

**BACKGROUND** ..... **D-5**

**STRAP RESEARCH OBJECTIVES** ..... **D-5**

**CHARGE QUESTIONS AND CONTEXT** ..... **D-6**

**SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS** ..... **D-7**
Overarching issues ..... D-7
Charge Question 1a ..... D-7
Charge Question 1b ..... D-9
Charge Question 1c ..... D-11
Charge Question 1d ..... D-14
Charge Question 1e ..... D-17

**SUMMARY LIST OF RECOMMENDATIONS** ..... **D-19**

**CONCLUSIONS** ..... **D-21**

**APPENDIX A: MEETING AGENDA** ..... **D-23**

**APPENDIX B: MATERIALS** ..... **D-25**
**Material Provided in Advance of the Meeting** ..... D-25
**Additional Material Provided During the Meeting** ..... D-25

## LIST OF ACRONYMS

| | |
|---|---|
| ASCE | American Society of Civil Engineers |
| AWWA | American Water Works Association |
| BOSC | Board of Scientific Counselors |
| CEC | Contaminants of emerging concern |
| CWA | Clean Water Act |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ERIS | Environmental Research Institute of the States |
| HAM | Harmful algal blooms |
| N | Nitrogen |
| NHD | National Hydrography Dataset |
| NIH | National Institutes of Health |
| NOAA | National Oceanic and Atmospheric Administration |
| NRCS | National Resources Conservation Service |
| NTWC | National Tsunami Warning Center |
| OGWDW | EPA's Office of Ground Water and Drinking Water |
| ORD | EPA's Office of Research and Development |
| OST | EPA's Office of Science and Technology |
| OWM | EPA's Office of Wastewater Management |
| OWOW | One World One Water |
| P | Phosphorus |
| PFAS | Per- and polyfluoroalkyl substances |
| SDWA | Safe Drinking Water Act |
| SSWR | Safe and Sustainable Water Resources |
| StRAP | Strategic Research Action Plan |
| TMDL | Total maximum daily load |
| USDA | U.S. Department of Agriculture |
| USGS | U.S. Geological Survey |
| WRF | Weather Research and Forecasting model |

## INTRODUCTION

The Safe and Sustainable Water Resources (SSWR) subcommittee of the U.S. Environmental Protection Agency's (EPA's) Board of Scientific Counselors (BOSC) met on April 23–24 to review the draft SSWR Strategic Research Action Plan (StRAP) for 2019–2022. This report contains the subcommittee's conclusions regarding the draft StRAP, organized as sets of responses to six charge questions. The report contains several suggestions for improving the content and communication power of the StRAP, and six recommendations the subcommittee believes important for strengthening the research program.

## BACKGROUND

EPA's SSWR program is devoted to ensuring safe drinking water and to protecting and restoring watersheds and aquatic ecosystems. The program's activities are designed to be responsive to the mandates of the federal Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), and other legislation.

SSWR cannot achieve success without well-planned and continuing cooperation with other EPA programs, federal and state agencies, tribes, and other public and private stakeholders. Providing adequate technical support for its wide-ranging Congressional mandates requires, at a minimum, understanding of the needs of the many stakeholders involved in managing risks to our water systems, developing the research needed to respond to these needs, and communicating the results of that research in useful ways. These are significant challenges, especially considering the continuing emergence of new threats to our water systems and the many technical difficulties that arise in efforts to manage existing threats.

The draft SSWR StRAP is EPA's proposed plan for meeting these challenges in the 2019–2022 time frame. The BOSC subcommittee has studied the plan, and also listened to presentations from its authors and the public regarding its foundations and content. The 19 members of the subcommittee have diverse scientific and technical backgrounds, all related to the content of the StRAP, and is well qualified to judge whether the research objectives are sound and respond to EPA's mandates to protect our nations waters and the people who consume them, and to ensure that this essential resource is sustained.

## STRAP RESEARCH OBJECTIVES

EPA's SSWR national research program has four overarching objectives:

> **Research Objective 1:** Improve Prediction and Early Accurate Detection of Contaminants — Continue advancements in environmental monitoring, modeling, methods, and other information that are needed to rapidly and reliably inform water quality decision-making at the national, state, tribal, and local levels.
>
> **Research Objective 2:** Assess Potential Impacts — Improve understanding of exposure pathways and effects of chemical and microbial contaminants on human health and aquatic ecosystems.
>
> **Research Objective 3:** Develop and Evaluate Approaches for Prevention and Mitigation — Expand solutions to prevent and mitigate water quality impairments using innovations in technology, market-based incentives, and other approaches.

**Research Objective 4:** Translate and Communicate Research – Provide practical solutions to water resource challenges through application of SSWR data, tools, and models, and disseminate this information through outreach activities.

To achieve these objectives, SSWR research is organized into three interrelated topics: watersheds, nutrients and harmful algal blooms, and water treatment and infrastructure. Each topic carries specific near- and long-term goals designed to yield practical tools and solutions for ensuring sustainable water resources. This SSWR Strategic Research Action Plan 2019–2022 outlines these topics and the overall SSWR program design. The StRAP serves as planning guide for the Office of Research and Development's (ORD's) laboratories and centers to design specific research products that contribute to the identified outputs. SSWR's scientific results and technologies will support the CWA objective to restore and maintain the chemical, physical, and biological integrity of the nation's waters and the SDWA to protect the quality of drinking water throughout the nation.

The SSWR subcommittee has evaluated the research program described in the StRAP, and its evaluation is summarized as sets of responses to the six charge questions found in the next section of the report.

## CHARGE QUESTIONS AND CONTEXT

The SSWR subcommittee was charged with five questions as follows:

Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any *other critical emerging* environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

# SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

## Overarching issues

**Translational Research as a Guide to Program Development**

One of SSWR's primary goals is successful transition of technology from the research community to the user community, typically at the state and local level. One of the best ways to achieve that is through collaboration with practitioners during development of those tools. Early interaction ensures that the product development is appropriate to the user needs. It also facilitates technology transfer as the researcher is able to observe, and resolve, transition challenges during the development process. Additionally, successful collaboration during development often creates a champion for transition to a broader audience, as the local practitioner typically has more credibility with the intended user audience than does the researcher.

StRAP includes two projects that will be conducted in collaboration with local users and we applaud SSWR for inclusion of such projects. However, they are expressed in the StRAP as one-off projects, with the SSWR staff even expressing during our interviews that one of the projects was included only because of a congressional mandate to do so. The StRAP would be improved by creating a separate section of the document highlighting SSWR plans to ensure translation of their work, calling out these partnership projects as examples of desirable activities and highlighting incentives being offered SSWR staff for implementing such collaborative projects. This section, particularly if it also incorporates the present communication section of the StRAP, would address the Committee's concern that "Translate and communicate research" is called out early in the document as one of the four pillars of SSWR research, but is not elaborated on in the remainder of the document with a strategy for achieving that pillar.

## Charge Question 1a

> Q.1a. Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

**Narrative**

EPA's and ORD Strategic Plans for 2018–2022 each describe three strategic goals. EPA's three strategic goals are: 1) its Core Mission to provide the Nation with clean air, land, and water, and to ensure chemical safety; 2) Cooperative Federalism for shared accountability, transparency, and participation with the public; and 3) the Rule of Law and Process to ensure compliance with the Law, create consistency and certainty, prioritize robust science, streamline and modernize permitting and reporting systems, and improve efficiency and effectiveness of its business processes. ORD's three strategic goals are: 1) Advancing environmental science and technology; 2) Cooperative Federalism to inform and support federal, state, tribal and local decision-making; and 3) Enhancing the ORD workforce and workplace. As described in the ORD Strategic Plan, ORD's strategic goals and objectives directly link to EPA's strategic goals and objectives, to ensure that ORD research outputs will assist EPA in achieving its goals and objectives.

To answer this charge question, the four research objectives[5], three research topics[6], and associated research areas and outputs[7] presented in the SSWR StRAP were evaluated against EPA's and ORD's stated strategic goals and objectives. For some EPA and ORD goals and objectives, this evaluation was not deemed relevant since they were not considered research oriented. These included improving EPA's business processes, modernizing EPA's permitting and reporting processes, and enhancing the ORD workforce and workplace.

**Strengths**

- The research objectives, topics, and areas described in the StRAP are aligned with the strategic goals identified by EPA and ORD. The associated research outputs are therefore expected to support EPA and ORD's strategic goals, especially EPA Strategic Goal 1 (Core Mission) and ORD Strategic Goal 1 (Advancing environmental science and technology).
- The stakeholder engagement described in the StRAP is aligned with and considered to support EPA's and ORD's Cooperative Federalism strategic goals.

**Suggestions**

- The StRAP describes four research objectives[5]. However, the remainder of the StRAP is organized by three research topics with associated research areas and outputs as summarized in Appendix 4. Under the current format, it is not clear how the four research objectives relate to the three research topics and associated areas and outputs. This could be clarified under the Program Objectives section and potentially detailed through a revision of Appendix 4.
- There is clearly programmatic overlap between EPA, its federal and non-federal partners, and other stakeholders in many of the research areas described in the StRAP. Where possible, we suggest that EPA identify such overlap and describe existing or planned coordination activities to maximize research complementarity, minimize duplication, and provide efficient expenditures.
- ORD should consider only using documents or surveys that identify potential research topics that it cannot verify as reliable and credible sources of input. For example, the Environmental Research Institute of the States (ERIS) survey may not be a good source as discussed under Charge Question 1b. It is further suggested that the stakeholder engagement process be clarified and documented early in the development of the StRAP so the participants, timeline, and expectations are known and transparent as the data is being collected. The approach should focus on gathering input from sources that can provide strategic insights on critical topics and will require interacting with some stakeholders at a higher level of responsibility than currently done.

.....

[5] The four research objectives identified in the SSWR StRAP are: 1) Improve Prediction and Early Accurate Detection of Contaminants; 2) Assess Potential Impacts; 3) Develop and Evaluate Approaches for Prevention and Mitigation; and 4) Translate and Communicate Research.

[6] The three research topics identified in the SSWR StRAP are: 1) Watersheds; 2) Nutrients and Harmful Algal Blooms; and 3) Water Treatment and Infrastructure.

[7] The three research topics identified in the SSWR StRAP each contain 3-4 research areas and a total of 31 research outputs, as summarized in Appendix 4 of the StRAP.

## Recommendations

The subcommittee offers this recommendation to ensure that the research outputs described in the StRAP support EPA's and ORD's Strategic Goals.

**Recommendation 1a.1:** While the research objectives, topics, and areas outlined in the StRAP are aligned with EPA's and ORD's strategic goals, it is less clear how success in meeting those goals will be evaluated. ORD's Strategic Plan talks specifically about measures of progress (e.g., increase the number of research products meeting customer needs under each ORD goal). Where possible, we suggest that the StRAP similarly describe measures of success for the different research outputs.

*EPA Response: The SSWR measures of success align with the ORD Strategic Plan–to increase the percentage of products meeting customer needs. The products developed to support the outputs were developed with the Office of Water and Regions to ensure the research products meet their expectations. The leadership of ORD and OW met during the StRAP planning closeout phase, and OW confirmed they were very satisfied with the research areas, outputs and products, as well as the engagement with SSWR during the planning process. SSWR will continue to engage with OW and Regions as we implement the research program, provide scientific support as they use our products after they are delivered, and in doing this, evaluate the usefulness and effectiveness of our research in helping solve environmental and public health problems. The ORD Strategic Metric (increase percentage products meeting customer needs) is being implemented annually through surveys sent to partners on product i. quality, ii. usability, and iii. timeliness. ORD is currently seeking approval to expand the survey recipients beyond Federal agencies to states and other groups, through an Information Collection Request that is undergoing OMB review and public comment. The BOSC will have additional opportunities to evaluate this engagement in future meetings that will be focused on StRAP implementation.*

## Charge Question 1b

> Q.1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

**Narrative**

The SSWR subcommittee was impressed by ORD's effort to solicit information about the needs of states, tribes, and regions, and to respond by aligning research activities with the needs identified by the partners. SSWR has clearly strengthened its partnership and stakeholder engagement within the EPA organization, including EPA's regional offices. However, results from outreach to state agencies, professional organizations, and academia show room for improvement, both in number of participants that provide input and, in the quality, or relevance of the input received.

Much of the information about partner needs came from ERIS surveys. Important concerns with the survey process were identified. The ERIS survey questions were not general enough to solicit the range of stakeholder concerned issues. The survey questions posed were very limited (11 questions, with "other" listed as question 12) and seemed biased towards specific research interests. For example, the question asking about the concern of "Toxics and Chemicals of Emerging Concern Including PFAS" led respondents to identify per- and polyfluoroalkyl substances (PFAS) over other potential contaminants such as pesticides or pharmaceuticals. The subcommittee was concerned that ORD had no input to

survey questions and that there was little transparency about how survey questions were developed. Survey questions to identify partner needs should not be leading questions but rather more open-ended. There needs to be greater transparency over the creation of survey questions and should involve input by ORD when possible. In addition, survey questions should be designed with more participants in mind through strategic partnerships (i.e., NOAA, AWWA, WRF, etc.).

Some research outputs identified by partners were not addressed in the StRAP, with insufficient explanation. For example, a partner in the National Tsunami Warning Center (NTWC) spring 2018 survey identified the research need for a "hydraulic fracturing water reuse study for evaluating ecological impacts." In the StRAP, ORD's response was "this need will not be addressed," with no further justification. Additional items identified by partners that are listed as not being addressed include: a) Groundwater remediation: would be beneficial to see data from past in situ efforts and designs related to hydro technologies; b) Nutrient impact on wastewater reservoirs from water reuse; and c) Human health & ecological effect studies for large vessel ships - dumping sewage and gray water in international waters. The surveys also identified resiliency challenges that are not addressed. The subcommittee urges greater transparency in explaining why partner-identified requests like these were denied. For example, ORD could respond by saying that these concerns are being addressed elsewhere in the EPA, or by other agencies with some specifics.

It is likely that research activity may not have been completed from the prior StRAP period that needs continuation. Uncompleted items should be mentioned, some of which may not have overlapped with current interests but still need continued attention. In addition, there should be clarification on why certain topics have been continued over topics that are no longer being addressed.

**Strengths**

- The subcommittee commends ORD for their effort to solicit information about the wide-ranging needs of states, tribes, and regions; and for their use of this information in guiding research program activities.
- The subcommittee commends ORD on the tangible research approaches that have been mapped out to address the key objectives identified by the partners. The research agenda outlined in the StRAP will further assist in providing solutions for safe and sustainable water resources in the states and regions, and to advance environmental protection.

**Suggestions**

- Justification should be provided for research needs identified by partners that will not be addressed by ORD. The subcommittee understands that research will not be performed for all the concerns suggested by stakeholders for a number of reasons. It is important to maintain as much transparency as possible with these stakeholders and describe why certain topics will and will not be addressed.
- Additional research expertise should be provided by ORD to further support needs of its state and federal partners. ORD has substantial expertise in synthetic data analysis, advanced measurements, and terrestrial and aquatic modeling that could be harnessed to provide specific answers to individual state and tribe needs. For example, ORD staff could work together with individual states to develop localized remediation plans, individual watershed total maximum daily loads (TMDLs), and detailed numeric nutrient criteria; going substantially beyond technical information or guidance toward providing new solutions that the states and tribes can use.

- Further consideration should be given to leveraging research expertise and maximizing the value of research expenditures through strategic partnerships. Given that ORD cannot perform all the potential research outlined either by stakeholders or through internal ORD researchers, partnerships with other federal agencies and private foundations should be explored so that limited funds can be leveraged and provide opportunities for others (i.e., DOE, USGS, NOAA, AWWA, WRF) to champion important research topics.

## Recommendations

The subcommittee offers one recommendation to capitalize on partner-identified needs.

**Recommendation 1b.1:** The EPA should make as clear as possible the specific mechanisms used to collect information on partner needs, and the paths from that information to the proposed research programs. The subcommittee initially had the impression that a survey conducted by ERIS, judged by the subcommittee to have several apparent shortcomings, was the principal means used to collect information. There were in place, however, other mechanisms to collect this critical information, but there is no clear record of how and from whom the information was collected. There is a lack of transparency regarding the practices used and questions asked, and of how it was insured the process was unbiased and as objective as possible. We recommend that the information gathered is specific to each of the six research areas. The partner needs are fundamental to the SSWR research program, and much more transparency is needed to ensure the adequacy of the resulting research proposals.

*EPA Response: To clarify questions about SSWR's engagement process, SSWR held follow-up phone meetings with the BOSC Subcommittee and described in detail the process by which the priorities of the Office of Water and Regions were collected and the path from the stated priorities to the research areas, outputs, and products. In summary, after initial range-finding with OW leadership, three topic workshops and eleven Research Area Coordination Teams (RACTs) comprised of ORD, OW, and Region staff worked to iteratively evaluate, prioritize, and shape the outputs and products over a one-year period. A pilot program to include state scientist representatives on a number of the internal RACTs was also instituted, under the Unfunded Mandate Reform Act (UMRA) FACA exemption. The ERIS survey and other targeted consultations provided additional input into this prioritization process. The EPA program and regional review during the StRAP planning closeout phase affirmed their satisfaction with this process. The SSWR StRAP's Partners and Stakeholders section has been edited to include more detail on this planning process. ORD has also conveyed information on BOSC concerns regarding the survey and opportunities for improvement through our contacts with ERIS.*

## Charge Question 1c

> Q.1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019-2022 time frame.

**Narrative**

The StRAP describes four overarching research objectives and then identifies three closely related topics under which the proposed research efforts are organized (watersheds, nutrients and harmful algal blooms [HABs], and water treatment and infrastructure). Presented under each topic are the broad research areas and programs that are identified by region, state, and tribal needs. These lists identify specific research

activities intended to be responsive to those needs. The process through which the proposed research will meet these needs are described in a series of 31 outputs. The 31 outputs collectively reflect the direction proposed for the SSWR in FY2019–2022. It is acknowledged that achieving these outputs will depend upon budgetary appropriations.

The subcommittee attempted to address this charge question by examining the proposed program as a whole. We examined whether the research objectives clearly reflect Agency and ORD priorities, whether the topics clearly provide understanding of the program's organizing framework, and whether the research areas and outputs, taken together, provide a vision that is both appropriate for EPA's mission and adequate to achieve the research objectives.

**Strengths**

- The StRAP provides a reasonably comprehensive examination of some the important challenges our country faces in providing safe and reliable water supplies within the context of EPA's mission. It also provides guidance on scientific, technological, and translational efforts required to respond to these particular challenges. At a broad level, the StRAP communicates how these needed efforts will support the EPA's mission and its various Congressional mandates, to provide a relatively clear path forward for addressing the EPA's highest priority research objectives for SSWR.
- The needs of various stakeholders, as described in the StRAP have been given high priority in the proposed research program, and the 31 outputs are generally satisfactory responses to those needs. The information, tools, and capabilities described in the outputs, if delivered in efficient and understandable ways, should provide substantial support for those stated needs.
- At a technical level, the StRAP provides a relatively clear, albeit very broad, vision of the leading requirements for advancing the proposed research efforts. Of particular value is the emphasis on expanded analytical methodologies, continued environmental monitoring, and enhanced modeling capabilities. Moreover, the focus on delivering tools directly to stakeholders is rightly highlighted.
- Overall, the StRAP is a well-conceived and thoughtful guide to (for) addressing many of EPA's and their stakeholder's highest priority issues within the context of EPA's SSWR research program.

**Suggestions**

- The subcommittee believes the StRAP could be improved to provide better understanding of its stated and implied strategic vision.
- Consider introducing some sense of program priorities.
  - Are the 31 outputs all of equal importance? Is there a difference between outputs that are intended to apply nationally and those that are to apply locally? It is perhaps not critical to identify specific priorities, but a discussion of the topic would be useful as the planning effort moves ahead to identify more specific research undertakings. Some guidance on priorities will support these objectives, as well as development of future budget documents.
- Consider introducing some discussion of how success over the 2019–2022 planning horizon will be measured and reported. A plan that does not include an approach for assessment of success of the overall program would seem to be deficient. The StRAP now contains a roadmap for progress but no plan for allowing stakeholders to understand whether objectives are being achieved in a timely manner.
- Consider reorganizing topics and providing clearer objectives for each of the tasks.

  - The three topics convey quite different messages about how the overall research program is organized, which adversely affects communication of the overall vision. While "Treatment and Infrastructure" reflects the research content clearly, "Watersheds" seems a "force-fit" for its content; "Nutrient and Algal Blooms" is an entirely different category of activities. There is, no doubt, a need for some type of categorization of research areas, but the current topics impede efforts by not articulating exactly what the SSWR is trying to achieve. Further, the relation between the four research objectives and the topics is difficult to track.
- Consider improving consistency in the wording of outputs.
  - Some outputs are fairly specific in what is to be expected from the research (e.g. Outputs 1 and 20); some are very broad and less clear (Outputs 5 and 23), and some are in between (Outputs 13 and 29). Not enough effort has gone into communicating specific expected outputs, and the program vision is somewhat blurred as a result.
- Consider accounting for unanticipated changes in scientific advances and consumer market demands that may require modifying targeted contaminants of emerging concern (CEC) lists. For example, over-the-counter and prescription sales volume or demands of popular pharmaceuticals may quickly or unexpectedly change when newer classes of similar drugs are approved or observed to have unexpected environmental effects. The StRAP responsiveness may be improved by giving thought to such issues. This would assure the Agency remains nimble and adaptable when priorities or changes to the threat landscape occurs.
- Consider uncertainties in capturing information on stakeholder needs. The StRAP responds well to the described stakeholder needs, but there is uncertainty regarding the methods used to capture and understand those needs. The StRAP should consider elaborating further on this issue and pointing to efforts needed to improve understanding of these needs in the future.
- Consider identifying unmet needs. The StRAP provides little sense of what is not captured in its research program. A discussion of this matter would not suggest the SSWR program is deficient but would reflect how well the program is in touch with future challenges. No research program is expected to be complete, but a program should reflect an awareness of the challenges that lie ahead.

## Recommendations

The subcommittee offers this one recommendation to improve and expand communication efforts.

**Recommendation 1c.1:** The SSWR should review the role of risk communication in its general communication efforts, its value to stakeholders, and of the significant guidance that is available from authoritative sources on appropriate strategies for communicating risk. Research Objective 4 (Translate and Communicate Research) is partially met in the StRAP. The outputs clearly and appropriately emphasize communication of results (data, tools, models) to stakeholders, and this is clearly essential to the SSWR program's success. There is, however, no mention of how to communicate information on risks to public health and the environment when discovered as a result of Agency research. Risk communication is far more complex than is communication of a strictly technical nature. Ineffective or unclear communication concerning human health or negative environmental impacts can have many adverse consequences, including distrust of agency results.

*EPA Response: We agree and have forwarded this recommendation to ORD's IOAA and Executive Council to consider for all six of the national research programs, noting too that this is an EPA priority as outlined by the Administrator. Agency and ORD-wide efforts on science translation and risk communication will be tailored and incorporated into SSWR research as they evolve. The BOSC will also have additional opportunities to evaluate these efforts in future meetings that are more focused on StRAP implementation.*

## Charge Question 1d

> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

**Narrative**

As the nation's pre-eminent research organization devoted to addressing and solving environmental problems associated with water, ORD has the difficult task of balancing the immediate pressing needs of its clients, with the need for addressing the nation's emerging threats and challenges. The current SSWR StRAP reflects the extensive effort that was invested in communicating with its clients about their needs. However, given the increasing threats to the nation's water resources and supplies (i.e., changing environmental conditions due to climate change, aging infrastructure, increased nutrient and contaminant loading, decreased water quantity and quality), and the potential for unknown threats and stressors resulting from genetic mutations, newly manufactured drugs and chemicals, and novel interactions resulting from extreme climatic events and warming, ORD must develop a parallel strategy for identifying *new and emerging* issues of concern and developing practical and cost-effective solutions.

**Strengths**

- The subcommittee commends the extensive communication with clients, including One World One Water (OWOW), regions, states, and tribes, to identify critical research needs.
- The StRAP identifies several very high-profile research topics in the Watershed and HAB programs to develop important technology needs and to integrate and leverage existing innovative technologies, including remote sensing and (unspecified) use of "omics". Also noted were efforts

to develop guidelines for the development of safe cyanotoxin levels in drinking and recreational waters.
- The subcommittee commends the focus on lower food webs dynamics, which can provide an "early warning system" for identifying human and environmental health threats.
- Further, the subcommittee commends the research emphasis on the emerging contaminants of nano/microplastics and PFAS.

**Suggestions**

The subcommittee noted several areas where new issues could be considered, or improvements could be made to the StRAP. These include:

- Better identify the link between Technical Support and Research, and the criteria used to elevate a request for support to the level of a research question and program. It is not clear to the panel that the survey was a particularly effective tool for identifying the key research questions that would best serve the regions, states, and tribes.
- Several pressing environmental problems were noted (pages 3-5) but were not further addressed within the Program Descriptions. These include Stormwater; Diminished Water Availability; and Wetlands.
- Several topics, such as omics were identified, but the research directions were too vague to understand ORD's intended direction.
- Although the focus on nano/micro plastics as an emerging contaminant is commended, the StRAP should make clear whether the focus is on developing measurement technology, on developing effects thresholds, or both.
- The StRAP has a heavy emphasis on evaluation of a single chemical group (PFAS), but needs a more holistic strategy for addressing a wider range of emerging contaminants.
- The topic of Resiliency is discussed in the Integration section but is not addressed elsewhere. The Resiliency research topics should be defined in the StRAP along with the recommended increase in focus on climate change effects.
- The Integration section does not address the potential for use of the USGS's new National Hydrology Dataset (NHD) products in the Watershed Program. Furthermore, the panel is unsure whether the list of topics presented in the StRAP for integration represent the full potential to maximize and leverage resources across programs.
- Consider additional strategies for incorporating community-engaged science, including use of Traditional Ecological Knowledge.
- The Communication Strategy relies heavily on traditional media and methods, e.g., peer reviewed papers and workshops for dissemination of results. Innovation in this Communication Strategy is suggested to increase appeal to younger audiences through use of social media and to more broadly disseminate research results through tools such as the EnviroAtlas.

## Recommendations

The subcommittee offers these three recommendations to identify critical emerging environmental needs or fields of expertise and specify topic areas where this program should consider investing resources.

**Recommendation 1d.1:** ORD should develop a parallel strategy for identifying and prioritizing emerging research opportunities and issues of concern.

The current StRAP was based on extensive communication with its clients about their current needs, but lacked a clear process for identifying and prioritizing horizon scanning research opportunities that are not yet on their client's radar. ORD must have the capacity and a systematic process to identify emerging issues that could threaten human and/or environmental health. Furthermore, institutional resources must be maintained to quickly address threats when they appear.

*EPA Response: We agree with this recommendation, both in the context of the SSWR portfolio and that of ORD as a whole, where we continue to emphasize the importance of identifying needs for anticipatory research. ORD's National Programs, in collaboration with other ORD and EPA leadership and through engagement with international scientific societies and the National Academies, regularly horizon-scan for near- and long-term emerging issues. In addition, EPA's Strategic Foresight team conducts these efforts on behalf of EPA and in collaboration with the federal family. A recent report from this group (released in May 2019), reported on approaches and practices for improving federal foresight efforts and means for integrating foresight work into strategic planning and decision making. ORD actively participates on the EPA Strategic Foresight team and will continue to be engaged moving forward. (https://altfutures.org/wp-content/uploads/2019/03/Foresight_in_Federal_Government_Accepted12-13-18.pdf).*

**Recommendation 1d.2:** Invest in addressing the ramifications of changing climate.

EPA is not a climate change management organization, but ORD does have responsibility for assessing how climate change will affect water quality management or how local management actions can exacerbate or lessen such effects. In particular, the StRAP should include elements that address the relationship between nutrient inputs and acidification, how shifting hydrologic regimes will affect implementation of the biological community assessment approach that EPA now relies on, and how changing temperature patterns will affect distribution of pathogens and harmful algal blooms.

*EPA Response: We agree with the importance of addressing the impacts of climate change, and note that EPA does have important roles regarding climate change, including research to support "comprehensive adaptation and disaster risk reduction strategies at national and local levels, including investment in infrastructure that is resilient to extreme weather events and disasters." https://www.meti.go.jp/press/2019/06/20190618008/20190618008_01.pdf This initial BOSC review of the StRAP was at the strategic level, and the next series of BOSC subcommittee meetings will be provided greater detail on the research products that support the outputs for each topic, including ORD research on resilience. We note that the initial BOSC subcommittee meeting was provided examples of climate-related work, such as research on 1) Nutrient Enhanced Coastal Acidification and Hypoxia (NECAH, a term coined by SSWR), 2) water reuse and enhanced aquifer recharge for solutions to water availability shortages, and 3) various models, including one that evaluates thermal stress on salmonid populations.*

*We agree that this work could be more visible in the high-level StRAP, so the Problem Statement was revised to: The interrelated challenges of impaired watersheds and water quality collectively threaten the Nation's water resources that support human and ecosystem health and a strong economy. These challenges include persistent and new chemical and microbial contaminants, antimicrobial resistance, excess nutrients and harmful algal blooms, aging water infrastructure, stormwater runoff, diminished water availability, knowledge gaps in the value of water quality, and how changing temperatures patterns and shifting hydrologic regimes will affect water quality management.*

**Recommendation 1d.3:** Develop/refine next generation environmental monitoring and assessment tools and technologies.

Monitoring technology is expanding exponentially, and ORD needs to be a leader in that field. The StRAP should consider increased investment in areas such as: a) Enhanced use of genomics for environmental monitoring, including measurement of extracellular DNA, b) Development of an emerging contaminants assessment strategy that includes non-targeted chemistry to assess known unknowns and bioanalytical screening to assess the unknown unknowns, and c) Use of automated monitoring technology development, such as unmanned drones for characterization and sample collection, and sensor development, d) Consideration of methods for incorporating traditional ecological knowledge in monitoring & assessment protocols.

*EPA Response: We thank the BOSC for this group of recommendations on the important topic of monitoring and assessment tools and technologies. SSWR touched on a number of examples in the StRAP (e.g., DNA applications for new NARS indicators, bioassays for wastewater and fit-for-purpose water reuse, sensor development). Similar to the response to recommendation d1.2, the next series of BOSC subcommittee meetings will provide greater detail on the research products that will address this recommendation. Unfortunately, ORD does not have authority to purchase or contract the use of unmanned drones—we are working toward resolving this shortcoming, but it requires Congressional approval. Regarding the incorporation of traditional ecological knowledge, SSWR has been communicating with the National Tribal Science Council and the National Tribal Water Council, and other tribal organizations. Most recently, SSWR participated in a formal Tribal Consultation to address specific needs related to lead and copper release in water distribution systems. One of the charge questions SSWR posed addresses sharing of traditional knowledge. The StRAP's Partner and Stakeholder section now includes: "In addition to state and tribal priorities, SSWR also considered the contribution states and tribes could make towards the Agency's objectives to provide for clean and safe water resources and cooperative federalism through the states' expertise and data and traditional ecological knowledge."*

## Charge Question 1e

> Q.1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

**Narrative**

We interpret market based approaches and prizes or challenges as targeting two distinct audiences: (1) industry and (2) secondary education institutions. In either case, to create successful incentives, it's important to engage and promote end user participation to develop the structure for incentives. We suggest working together with industry associations (e.g. American Society of Civil Engineers [ASCE], American Water Works Association, and State Water Environment Associations) for a "finger on the pulse" of practitioners.

Regarding educational institutions, we suggest targeting specific populations, but consider that undergraduate engineering programs have very little flexibility and high demands on student time for course work, whereas graduate student schedules are more flexible. High school opportunities are entirely different. To encourage participation, we suggest giving the competition structure support, and give greater recognition to faculty and teachers behind the student teams. Opportunities to engage corporations to partner may raise their corporate profile as good stewards and promote education amongst these stakeholders.

In considering a plan for developing new incentives or challenges, it would be useful to understand the success of previous efforts. To date, how has EPA measured the success of incentives or challenges? These represent substantial investments in time and volunteer work (e.g., for judging, etc.). What evidence is there of a connection between an incentive or challenge to change the broader community's behavior supporting EPA's objectives under the CWA and SDWA? For example, has EPA compiled information on previous competitions or incentives and their long-term impacts? If so, can this be used for public interest/good PR? We consider communicating success stories important.

We are aware of several tertiary education sector challenges. Does EPA have any activities directed to high school audiences?

**Strengths**

- Partnerships with the National Institutes of Health (NIH), the U.S. Department of Agriculture (USDA), and USGS.
- Partnerships with tertiary education institutions such as Campus RainWorks Challenge.
- Programs such as National Municipal Stormwater and Green Infrastructure Awards Program.
- Challenges such as: Nutrient Sensor Action, Advanced Septic Nitrogen Sensor and Arsenic Sensor.

**Suggestions**

- Have regional EPA offices partner with state regulatory counterparts; in particular, the state regional basin coordinators who are responsible for assuring that the regulated community develops and implements TMDLs in their respective basins or watersheds. The goal of this partnership is to reinforce the implicit rewards that a given sector of the regulated community can realize if they meet the TMDL goals of improved water quality.
    - For example, if a wastewater treatment plant with known levels of mercury in its discharge, and the receiving stream is water quality limited for mercury, can develop and implement a mercury minimization plan to effectively reduce the concentration in its discharge, then the state may be able to reduce or lift restrictions on fish consumption.
    - A secondary benefit may be that after word of this success story spreads, more anglers will come into the area, boosting the local economy, and providing a safer environment for those who like to eat what they catch.
- Provide incentives for market based approaches such as streamlined or reduced permitting requirements, grants to assist with initial development, or industry recognition to encourage innovative development to reduce nutrients. Methods such as algal harvesting have a great amount of potential.
- Work with innovation incubators and investors to better understand the emerging innovation economy, and better understand where market based incentives might best be targeted.
- Pursue opportunities for EPA staff to serve as visiting instructors. Teachers are more prone to include new material if they do not have to create it all themselves. A co-benefit to EPA staff is to stay current on topics at hand.
- Explore technologies for harvesting and reusing materials captured in storm water treatment practices (i.e., storm water control measures or best management practices). Heavy metals might be more of an economic incentive, whereas there is generally more data on nutrient capture.
- Develop programs to encourage extracting nitrogen and phosphorus from the soil profile or runoff. Nitrogen (N) and phosphorus (P) are currently inexpensive; thus, it is easier for farmers to continue applying more, rather than harvesting what is already building up in the soil. Successful examples from southern California nurseries who are harvesting and reapplying their own

irrigation water, thus substantially reducing application of new N and P. Programs should be developed to collaborate with regions, USDA, and/or state extension services.

- Create incentives for using agricultural byproducts that would otherwise contribute to nutrient loading and generating electricity. An existing example emerges from a power company that seeks converting methane from hog waste digestion to electricity.
- Create partnerships to address reducing sediment loads from construction, which is not currently mentioned in the StRAP. Construction sediment loading is a significant issue for watershed management, especially in highly developed urban areas.
- Create partnership/incentive for water conservation such as a *Fit Bit* for domestic water use. What would drive/encourage people to continue conservation after droughts and mandatory conservation ends?
- Conduct a detailed literature search of the hundreds of case studies that provide insights on how to introduce more market related incentives for environmental protection, such as *Economic Valuation of River Systems.*
- Evaluate collaboration with Franz Theodore Stone Laboratory, Ohio State University's S. Bass Island Lake Erie campus and Algal and Water Quality Laboratory. The Lab allows researchers to identify plankton, measure chlorophyll content and cyanobacteria toxins, analyze organic and inorganic suspended solids and test for nutrients such as phosphorus and nitrogen.
- Evaluate collaboration with The Great Lakes Protection Fund, a publicly capitalized, private corporation created in 1969 by the governors of states surrounding the Great Lakes. The Fund's mission is to identify, demonstrate and promote regional action to enhance the health of the Great Lakes ecosystem.
- The Agriculture Applied Economics Association includes a large sub-group of environmental and natural resource economists. They have been involved in hundreds of research projects and case studies estimating the benefits and costs as well as market incentives for many forms of environmental protection/pollution control. This could be and existing valuable body of work for ORD to tap into.

### Recommendations

The subcommittee did not offer any recommendations for Charge Question 1e.

## SUMMARY LIST OF RECOMMENDATIONS

This section provides a listing in a single location of the recommendations provided earlier in the report in response to each charge question.

### Charge Question 1a. Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

- **Recommendation 1a.1:** While the research objectives, topics, and areas outlined in the StRAP are aligned with EPA's and ORD's strategic goals, it is less clear how success in meeting those goals will be evaluated. ORD's Strategic Plan talks specifically about measures of progress (e.g., increase the number of research products meeting customer needs under each ORD goal). Where possible,

we suggest that the StRAP similarly describe measures of success for the different research outputs.

Charge Question 1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

- **Recommendation 1b.1**: The EPA should make as clear as possible the specific mechanisms used to collect information on partner needs, and the paths from that information to the proposed research programs. The subcommittee initially had the impression that a survey conducted by ERIS, judged by the subcommittee to have several apparent shortcomings, was the principal means used to collect information. There were in place, however, other mechanisms to collect this critical information, but there is no clear record of how and from whom the information was collected. There is a lack of transparency regarding the practices used and questions asked, and of how it was insured the process was unbiased and as objective as possible. We recommend that the information gathered is specific to each of the six research areas. The partner needs are fundamental to the SSWR research program, and much more transparency is needed to ensure the adequacy of the resulting research proposals.

Charge Question 1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

- **Recommendation 1c.1**: Research Objective 4 (Translate and Communicate Research) is partially met in the StRAP. The outputs clearly and appropriately emphasize communication of results (data, tools, models) to stakeholders, and this is clearly essential to the SSWR program's success. There is, however, no mention of how to communicate information on risks to public health and the environment when discovered as a result of agency research. Risk communication is far more complex than is communication of a strictly technical nature. Ineffective or unclear communication concerning human health or negative environmental impacts can have many adverse consequences, including distrust of Agency results. The SSWR should review the role of risk communication in its general communication efforts, its value to stakeholders, and of the significant guidance that is available from authoritative sources on appropriate strategies for communicating risk.

Charge Question 1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

- **Recommendation 1d.1**: ORD should develop a parallel strategy for identifying and prioritizing emerging research opportunities and issues of concern.

  The current StRAP was based on extensive communication with its clients about their current needs, but lacked a clear process for identifying and prioritizing horizon scanning research opportunities that are not yet on their client's radar. ORD must have the capacity and a systematic

process to identify emerging issues that could threaten human and/or environmental health. Furthermore, institutional resources must be maintained to quickly address threats when they appear.

- **Recommendation 1d.2:** Invest in addressing the ramifications of changing climate.

  EPA is not a climate change management organization, but ORD does have responsibility for assessing how climate change will affect water quality management or how local management actions can exacerbate or lessen such effects. In particular, the StRAP should include elements that address the relationship between nutrient inputs and acidification, how shifting hydrologic regimes will affect implementation of the biological community assessment approach that EPA now relies on, and how changing temperature patterns will affect distribution of pathogens and harmful algal blooms.

- **Recommendation 1d.3:** Develop/refine next generation environmental monitoring and assessment tools and technologies.

  Monitoring technology is expanding exponentially, and ORD needs to be a leader in that field. The StRAP should consider increased investment in areas such as: a) Enhanced use of genomics for environmental monitoring, including measurement of extracellular DNA, b) Development of an emerging contaminants assessment strategy that includes non-targeted chemistry to assess known unknowns and bioanalytical screening to assess the unknown unknowns, and c) Use of automated monitoring technology development, such as unmanned drones for characterization and sample collection, and sensor development, d) Consideration of methods for incorporating traditional ecological knowledge in monitoring & assessment protocols.

### Charge Question 1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

- None.

## CONCLUSIONS

The SSWR subcommittee believes the StRAP for 2019–2022 provides a reasonably comprehensive examination of the important challenges our country faces in providing reliably safe and sustainable water supplies and does so within the context of the EPA's mission and its mandate to partner with relevant stakeholders. The StRAP also provides, at a broad level, guidance on the scientific, technological and translational efforts required to respond to these challenges. The StRAP should hold up quite well to scrutiny by technical experts, based on the review undertaken by the SSWR subcommittee.

The subcommittee also found considerable strength in the efforts to respond to identified stakeholder needs and noted substantial understanding of and responses to emerging threats, such as those associated with whole classes of perfluorinated compounds and microplastics. Partnerships with other government research organizations and tertiary educational institutions were cited as strengths by the subcommittee.

The StRAP's elucidation of 31 research outputs – the expected results of the identified research areas and their relationships to stakeholder needs – was found by the subcommittee to be a valuable tool for evaluating the strength of the overall research program. The outputs explicitly define where the proposed research is heading, and its ultimate value in meeting overall objectives.

The subcommittee provided many suggestions for program and StRAP improvement. The most important of these, as reflected in the emphasis given to them in the charge question responses, concern the value of providing documentable measures of program success; the need to deal with uncertainties regarding the reliability of methods currently used to identify stakeholder needs; the importance of "horizon scanning" for capturing emerging threats; and the unrealized potential of market-based incentives for mitigating risks. The absence of priorities for the proposed research is noted in several suggestions, but the subcommittee recognizes that at this early phase of research planning, priority-setting is not a practical step the agency can undertake.

The subcommittee has six recommendations for the SSWR to consider. Several of the recommendations are focused on clarifying aspects of the StRAP, and in improving communication of its major messages, while others focus on emerging threats that are not sufficiently planned for in the StRAP. The subjects of communicating and translating research in effective ways are also highlighted in the recommendations.

The subcommittee has also emphasized one overarching issue – the potential value for research planning that explicitly incorporates, at an early stage, and in collaboration with stakeholders, the plan for translation of the research results. Future StRAPs might explicitly include strategies for achieving successful translations of research findings.

# APPENDIX A: MEETING AGENDA

**Environmental Protection Agency**
**Board of Scientific Counselors (BOSC)**
**Safe and Sustainable Water Resources (SSWR) Subcommittee**

**Meeting Agenda**
**April 23-24, 2019**
William Jefferson Clinton East 1153
1300 Pennsylvania Ave, NW Washington, DC 20460

| TIME | TOPIC | PRESENTER |
|---|---|---|
| **April 23, 2019** | | |
| 8:15-9:00 | Registration | |
| 9:00-9:10 | Welcome and Opening Remarks | Joseph Rodricks, Chair<br>Robert Blanz, CoChair |
| 9:10-9:45 | Subcommittee Introductions | Subcommittee |
| 9:45-10:00 | DFO Welcome | Tom Tracy |
| 10:00-10:15 | ORD Welcome | Bruce Rodan |
| 10:15-10:45 | Review of Charge Questions | Joseph Rodricks, Chair<br>Robert Blanz, CoChair |
| 10:45-11:00 | *Break* | |
| 11:00-11:15 | Public Comments | |
| 11:15-11:30 | SSWR Strategic Research Action Plan Overview | Suzanne van Drunick<br>Joe Williams |
| 11:30-12:15 | Topic 1: Watersheds | Rick Greene |
| 12:15-1:15 | *Lunch (on your own)* | |
| 1:15-2:00 | Topic 2: Nutrients and Harmful Algal Blooms | Scot Hagerthey<br>Hale Thurston |
| 2:00-2:45 | Panel Discussion: Office of Water's and Regional Perspectives on SSWR StRAP<br>Benita Best-Wong, OW Principal Deputy Assistant Administrator<br>John Goodin, OWOW Director<br>Jennifer McLain, OGWDW Acting Director<br>Deborah Nagle, OST Director<br>Andrew Sawyers, OWM Director<br>Carole Braverman, Region 5 Regional Science Liaison | Office of Water &<br>Region 5 |
| 2:45-3:00 | *Break* | |

| | | |
|---|---|---|
| 3:00-3:45 | Topic 3: Water Treatment and Infrastructure | Chris Impellitteri |
| 3:45-4:00 | SSWR Communications and Outreach | Michelle Latham |
| 4:00-5:00 | BoSC Executive Session –<br>Establish Charge Question Workgroups | Joseph Rodricks, Chair<br>Robert Blanz, CoChair |
| 5:00 | Adjourn | Tom Tracy |

| **April 24, 2019** | | |
|---|---|---|
| 9:00-10:00 | Subcommittee Discussion<br>SSWR Response to Subcommittee Questions | Subcommittee<br>SSWR Team |
| 10:00-10:15 | *Break* | |
| 10:15-12:00 | BoSC Executive Session –<br>Workgroup Discussion and Writing | Subcommittee |
| 12:00-1:00 | *Lunch* | Subcommittee |
| 1:00-2:30 | Workgroup Presentations | Subcommittee<br>SSWR Team |
| 2:30-2:45 | Next Steps | Joseph Rodricks, Chair<br>Robert Blanz, CoChair |
| 2:45 | Adjourn | Tom Tracy |

# APPENDIX B: MATERIALS

## Material Provided in Advance of the Meeting

***Materials to Support the Charge Questions***

- Agenda
- Charge questions
- Draft SSWR StRAP
- SSWR Overview for BOSC Meeting
- SSWR Research Program Overview
- EPA Strategic Plan https://www.epa.gov/planandbudget/strategicplan
- ORD Strategic Plan

***Informational Materials***

- Communication and Outreach Highlights
- Consumer Tool for Identifying Point of Use
- Nutrients and Harmful Algal Blooms Research
- Watersheds Resource
- Water Treatment and Infrastructure Research

## Additional Material Provided During the Meeting

- BOSC SSWR subcommittee roster

BOSC
BOARD OF SCIENTIFIC COUNSELORS

# REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

## BOSC SUSTAINABLE AND HEALTHY COMMUNITIES SUBCOMMITTEE


Courtney Flint, Ph.D. (Chair)
*Utah State University*

Matthew Naud, MPP, MS. (Vice Chair)
*Senior Consultant, adapt.city*

Jay S. Golden, Ph.D.
*East Carolina University*

Kimberly Gray, Ph.D.
*Northwestern University*

Elena Irwin, Ph.D.
*Ohio State University*

James Kelly, MS.
*Minnesota Department of Health*

Rainer Lohmann, Ph.D.
*University of Rhode Island*

Jonathan Meiman, M.D.
*Wisconsin Division of Public Health*

Donald Nelson, Ph.D.
*University of Georgia*

Barrett Ristroph, Ph.D.
*Ristroph Law, Planning, and Research*

Leslie Rubin, M.D.
*Morehouse School of Medicine; Break the Cycle of Health Disparities, Inc.*

Derek Shendell, D. Env, MPH
*Rutgers School of Public Health; NJ Safe Schools Program*

Michael Steinhoff, MPA, MSES
*ICLEI, Local Governments for Sustainability-USA*


EPA Contact
**Jace Cujé, Designated Federal Officer**

August 19, 2019

# CONTENTS

**LIST OF ACRONYMS** ..... **E-4**

**INTRODUCTION** ..... **E-6**

**BACKGROUND** ..... **E-6**

**STRAP RESEARCH OBJECTIVES** ..... **E-7**

**CHARGE QUESTIONS AND CONTEXT** ..... **E-7**

**SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS** ..... **E-8**
Charge Question 1a ..... E-9
Charge Question 1b ..... E-12
Charge Question 1c ..... E-17
Charge Question 1d ..... E-20
Charge Question 1e ..... E-24
Charge Question 2 ..... E-27
Charge Question 3 ..... E-30

**SUMMARY LIST OF RECOMMENDATIONS** ..... **E-34**

**CONCLUSIONS** ..... **E-37**

**APPENDIX A: MEETING AGENDA** ..... **E-38**

**APPENDIX B: MATERIALS** ..... **E-41**
Material Provided in Advance of the Meeting ..... E-41
Additional Material Provided During the Meeting ..... E-42
Additional Material Provided After the Meeting ..... E-42

## LIST OF ACRONYMS

| | |
|---|---|
| A-E | Air and Energy Research Program |
| APA | American Psychological Association |
| APHA | American Public Health Association |
| ASTHO | Association of State and Territorial Health Officials |
| ASTSWMO | Association of State and Territorial Solid Waste Management Officials |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BOSC | Board of Scientific Counselors |
| CDC | Centers for Disease Control and Prevention |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CSS | Chemical Safety for Sustainability |
| ECOS | Environmental Council of the States |
| EJ | Environmental justice |
| EPA | U.S. Environmental Protection Agency |
| ERIS | Environmental Research Institute of the States |
| FEMA | Federal Emergency Management Agency |
| FY | Fiscal year |
| HHRA | Human Health Risk Assessment Program |
| HHS | United States Department of Health and Human Services |
| HS | Homeland Security |
| I/O | Input/output |
| ICLEI | International Council for Local Environmental Initiatives |
| ICMA | International City Managers Association |
| IEUBK | Integrated Exposure Uptake Biokinetic model |
| LCA | Life-cycle analysis |
| LCOs | ORD's laboratories, centers, and offices |
| LUST | Leaking Underground Storage Tanks |
| NAICS | North American Industry Classification System |
| NGO | Non-governmental organization |
| NIEHS | National Institute of Environmental Health Sciences |
| NIFA | National Institute of Food and Agriculture |
| NIH | National Institutes of Health |
| NLC | National League of Cities |
| NOAA | National Oceanic and Atmospheric Administration |
| NPL | Superfund National Priority List |
| OLEM | EPA's Office Land and Emergency Management |
| ORD | EPA's Office of Research and Development |
| P3 | People, Prosperity and the Planet |
| PACT | Partner Alliance and Coordination Team |
| PEHSU | Pediatric Environmental Health Specialty Unit |
| PFAS | Per- and polyfluoroalkyl substances |
| R2R2R | Remediation to Restoration to Revitalization |
| RACT | Research Area Coordination Team |
| RCRA | Resource Conservation and Recovery Act |
| RESES | Regional Sustainability and Environmental Sciences Research Program |

| | |
|---|---|
| ROE | EPA's Report on the Environment |
| SARA | Superfund Amendments and Reauthorization Act |
| SHC | Sustainable and Healthy Communities |
| SHEDS | Stochastic Human Exposure and Dose Simulation |
| SMM | Sustainable Materials Management |
| SSWR | Safe and Sustainable Water Resources |
| STAR | EPA's Science to Achieve Results Program |
| STEM | Science, Technology, Engineering, and Mathematics Programs |
| STEAM | Science, Technology, Engineering, Arts, and Mathematics Programs |
| StRAP | Strategic Research Action Plan |
| USEEIO | United States Environmentally-Extended Input-Output Model |
| USGS | United States Geological Survey |
| USFS | United States Forest Service |
| UV | Ultraviolet |
| VI | Vapor intrusion |

## INTRODUCTION

The mission of the U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) is to provide the best available science and technology to inform and support public health environmental decision-making at the federal, state, tribal, and local levels, addressing critical environmental challenges and anticipating future needs through leading-edge research. ORD's Sustainable and Healthy Communities (SHC) research program provides the decision tools and data that communities need to make proactive, strategic decisions aimed at a prosperous, more environmentally sustainable future. SHC is one of the Agency's six highly integrated national research programs. The other five are Air and Energy (A-E), Chemical Safety for Sustainability (CSS), Homeland Security (HS) Human Health Risk Assessment (HHRA), and Safe and Sustainable Water Resources (SSWR).

ORD has developed a strategic research action plan (StRAP) to guide each research program. The draft 2019–2022 StRAPs orient ORD's research to respond to Administration priorities, as expressed in EPA's Strategic Plan. Additional detail on specific research needs has been identified through formal discussions with EPA programs and regions over calendar year 2018. Development of this third iteration of the StRAPs also emphasizes consultation with the states to identify their needs, particularly through the Environmental Council of the States (ECOS), along with engagement with the tribes.

The consolidated EPA program and region, state, and tribal research needs are structured in the StRAPs under topics, which are organized into research areas, and then detailed into draft research outputs (Appendix 1 of each StRAP). The outputs, in turn, will serve as the focus for future engagement with EPA ORD Laboratories, Centers, and Offices (LCOs) to identify research products that address the identified needs. ORD will also maintain engagement with partners throughout the research process to optimize the utility of the research products to meet their needs.

## BACKGROUND

The Board of Scientific Counselors (BOSC) SHC subcommittee was established to provide program-specific advice to EPA's SHC research program. The mission of the SHCRP is to conduct research and deliver products that improve the capability of EPA to carry out its responsibilities, including cleaning up communities, making a visible difference in communities, and working toward a sustainable future. The SHC program conducts applied, relevant research and aims to provide the knowledge, data, and tools needed to meet today's needs without compromising the ability of future generations to meet their needs in ways that are economically viable, beneficial to human health and wellbeing, and socially just, while supporting local communities seeking to become more sustainable. The program plans to engage the subcommittee over the next several years to provide advice on the program's portfolio and to assess progress in addressing EPA's needs.

ORD is seeking input from the BOSC on the draft StRAP documents and proposed research strategies therein. The emphasis is on advancing ORD research that can successfully address the needs identified by EPA programs, regions, states, and tribes. This BOSC review at the strategic planning phase will be followed by regular BOSC reviews of research activities over the course of StRAP3 implementation. The subcommittee convened for a face-to-face, public meeting on April 2–3, 2019 at EPA's Research Center in Research Triangle Park, NC. The focus of the meeting was on the EPA ORD Public Review Draft StRAP (February 2019), and review of three key topic areas within the SHC program's portfolio.

## STRAP RESEARCH OBJECTIVES

The StRAP describes a research portfolio that delivers science-based solutions. It is organized into three research topics:

**Contaminated Sites: Accelerating Cleanups.** The objective is to provide cost-efficient, rapid, and effective technical support and innovative methods for site characterization and cleanup, especially for complex site-specific issues; contribute to EPA program guidance and other technical support to manage contaminated groundwater (present at 85% of Superfund National Priority List [NPL] sites), leaking underground storage tanks, and mine waste; and to provide science-based approaches so that EPA's Office of Land and Emergency Management (OLEM), EPA regions, and states can better engage in effective restoration of contaminated sites. The results can inform the public as they participate in the selection of remediation options.

**Waste and Sustainable Materials Management: Reducing the Burden of Contamination.** The objective is to develop an integrated approach to materials management, including the need to evaluate landfill performance and its long-term impact on human health and the environment. Many existing materials considered to be either hazardous or non-hazardous waste intended for some form of disposal could potentially be reused, recycled, or reprocessed into other resources. Sustainable Materials Management (SMM) considers the full life cycle of materials thereby reducing toxics and greenhouse gases, reducing unnecessary consumption of natural resources, reducing emissions, beneficially using waste materials, and protecting human health and the environment.

**Healthy and Resilient Communities: Revitalizing Communities from Contamination and Natural Disasters and Extreme Weather Events.** The objective is to increase community resilience by reducing potential risks, promoting health, and revitalizing communities. Research under this objective will identify links between these desirable outcomes and effective site restoration and the provision of ecosystem services and health-promoting features of the built and natural environments. This research includes support for the Agency's Goal 6 and others stipulating that all, including susceptible and vulnerable sub-groups (e.g., children, elderly, minority communities), should benefit from remediation, restoration, and revitalization efforts (R2R2R). It also includes understanding the challenges associated with preparing for and recovering from the impacts of hazards, disasters and extreme weather events, especially when these might result in contaminants migrating from containment sites.

## CHARGE QUESTIONS AND CONTEXT

The charge questions were designed to assist the subcommittee in structuring its discussion and its feedback to SHCRP. By way of context, the subcommittee was informed that ORD has taken on a new strategic metric that is intended to measure and improve ORD's direct responsiveness to Agency needs. The Agency has asked ORD to "Refocus the EPA's robust research and scientific analysis to inform policy making," and to meet and improve on the following Strategic Measure: By September 2022, increase the number of research products meeting customer needs. The charge questions, therefore, ask the subcommittee to assess how responsive SHC's StRAP is to broad Agency directions, specific program and regional office needs, and the needs of Agency stakeholders in the states and tribes. They ask if the program's explanations are clear, if there are important topics within the scope of SHC that the StRAP does not address, and to assist subcommittee members as it considers mechanisms to promote innovative solutions.

Accordingly, the SHC subcommittee was charged with five questions StRAP-related questions, and two research program-specific questions as follows:

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?
>
> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?
>
> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.
>
> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any *other critical emerging* environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?
>
> Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?
>
> Q.2: SHC's StRAP is set-up as a series of problem statements with solutions (labeled as Outputs). This is the approach we have used to address partner-identified needs (see Q.1b above). Is this approach helpful in identifying research that is likely to meet the needs of EPA's program and regional offices? What about the needs of the states and tribes?
>
> Q.3: At the request of EPA's Regions, we have included the impact of natural disasters (e.g., severe weather, wildfires) in research areas 9 and 10. The focus is on how these types of disasters impact contaminated site remediation and restoration and community resilience. What suggestions does the subcommittee have for making this research more efficacious?

## SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

The BOSC SHC subcommittee commends the work of SHC program scientists, administrators, and supporting staff. The body of work presented throughout the BOSC deliberations is an impressive display of EPA's capabilities and the size of the challenges they are faced with in pursuit of protecting human health and the environment. The SHC StRAP shows that the program's researchers are clearly thinking holistically about the research needs and approaches, and are seeking not only to advance scientific knowledge and develop the needed technologies, but also to involve stakeholders and address broader economic and social questions relating to community revitalization, resilience, and development. The depth of knowledge displayed by the SHC National Program Director and Deputy National Program Director is impressive. Their ability to speak extemporaneously on areas of related research and to respond to subcommittee member questions displayed a high degree of engagement with their staff and broad understanding of the complex issues under investigation.

We appreciate how the SHC research program provides scientific solutions and technical support to EPA partners and state and tribal decision makers to remediate and restore our nation's most challenging and complex contaminated sites. This work will develop permanent remedies and innovative treatment technologies (as specified by the Superfund Amendments and Reauthorization Act, or SARA) that are needed to accelerate both the pace and cost reduction of cleanups, while also returning contaminated sites to safe and productive use by communities.

We recognize that there may be recommendations made within this document that are currently already underway but were not shared with us in the limited time the subcommittee was together. We also recognize that ORD programs are currently working on implementation plans with more details on products related to the research problems and outputs. We look forward to learning more in upcoming meetings and the response to these recommendations by SHC staff.

In the responses to charge questions below, we acknowledge outstanding strengths in the SHC StRAP and program and offer a variety of suggestions and recommendations for consideration. Across the SHC topics, a few overarching themes have emerged. We highlight the value of additional metrics to help monitor progress as SHC moves from needs and problems through the research process on the way to helpful outputs and outcomes. We encourage more long-term focus in addition to time-sensitive acute and near-term issues. We suggest attention to making research from Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites available for managing additional contaminated sites. We encourage more specificity regarding prevention, preparedness, and vulnerability reduction including cross-cutting emphasis on disasters, extreme weather events, and climate change[8] throughout SHC's topic areas. These areas and more are discussed below.

## Charge Question 1a

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

**Narrative**

The report is well organized with a clear focus on Contaminated Sites, Waste and Sustainable Materials Management, and Healthy and Resilient Communities tied to EPA/ORD strategic priorities. The EPA Strategic Plan calls for the revitalization of land and the prevention of contamination. Throughout the EPA Strategic Plan, there is a call for attention to vulnerable populations. ORD's Strategic Goals include supporting decision-making at all scales by making research results, tools, and technical expertise more widely known and available to federal, state, tribal, and local partners. The research outlined in Topic 2 of the SHC StRAP provides needed support to states in helping them to make informed decisions on the safe and appropriate beneficial use and reuse of different material types, and supports the Agency's core mission by looking at materials management from a systematic point of view through the lens of life cycle assessment. The SHC StRAP's focus in Topic 3 on identifying susceptible and vulnerable sub-groups and providing forecasting tools for evaluation and measuring effects is a positive start on addressing vulnerability in connection with EPA and ORD priorities. SHC is guided by a robust definition of resiliency that not only focuses on coping with disturbance and maintaining essential function, identity, and

.....

[8] **USGCRP**, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018

structure of socio-ecological systems, but also the capacity for adaptation, learning, and transformation. In this way, the StRAP is forward looking and has the potential to pull communities forward through the revitalization process.

We offer suggestions on ways to enhance the response to Agency priorities, including adding more explicit attention to climate change[8] as it relates to contamination, waste management, and community resilience, clarifying research attention to prevention and preparedness and ways to reduce community vulnerabilities related to contamination, and workforce development.

**Strengths**

- It is clear that SHC is working collaboratively with other national research programs and agencies on site characterization and remediation as well as chemicals of immediate concern. This is a good example of cooperative federalism outlined in EPA and ORD Strategic Plans.
- SHC staff working in this area have a high degree of technical expertise, particularly in regard to the highly complex mix of disciplines required to guide the safe management of hazardous and municipal solid waste disposal facilities.
- The StRAP acknowledges the importance of engaging with local stakeholders throughout the process of R2R2R in order to build resilience in contaminated socio-ecological systems. In this way, the StRAP responds to EPA's goal of cooperative federalism by increasing transparency and public participation, by creating tools for community-based environmental work, and by facilitating multi-directional communication between the public and environmental agencies.
- By reporting indicators through the Report on the Environment (ROE) and EnviroAtlas and interpreting and forecasting indicator trends, SHC's StRAP supports the EPA's and ORD's priorities associated with creating consistency and certainty as well as prioritizing robust science.

**Suggestions**

- **Topic 2 Connections to Agency Priorities**: While the SHC StRAP is in general strongly focused on goals defined in the ORD and EPA Strategic Plans, there is not a clear connection to the highly ambitious clean-up goals articulated in the EPA Strategic Plan with respect to contaminated sites, brownfield and Leaking Underground Storage Tanks (LUST) clean-up and turnover. In the forthcoming implementation plan for the SHC StRAP, we look forward to seeing greater detail on how SHC research will be implemented to support specific Agency priorities and goals.
- **Prevention:** While the SHC StRAP does a strong job of identifying opportunities to remediate contamination, more attention should be focused on how the research program and collaboration with program offices addresses contamination prevention contamination to align with EPA's Objective 1.3, "Revitalize Land and Prevent Contamination". It would be helpful for the StRAP to more clearly demonstrate how SHC's research program on R2R2R addresses contamination prevention related to the risk of disasters or extreme weather events interacting with contaminated sites. While SHC's emphasis on revitalization goes appropriately *beyond* disaster management's consideration of recovery, the notion of prevention is likewise important to attempt to avoid further contamination. As section 103(B) of the Great Lakes and Lake Champlain Act of 2002 states, a project is eligible that "prevents further or renewed contamination of sediment." [9] Deeper research consideration of state and community context and other site-specific and environmental processes with a specific focus on prevention would also help to meet

.....

[9] https://www.govinfo.gov/content/pkg/PLAW-107publ303/html/PLAW-107publ303.htm

new statutory requirements to improve the safety of chemicals in commerce (from the EPA Strategic Plan). See additional ideas in response to Charge Question 3.

- **Research on Reducing Vulnerabilities:** EPA's Goal 2 of cooperative federalism involves establishing active platforms for public participation and building capacity of vulnerable community stakeholders. While the identification of susceptible and vulnerable subgroups is central to SHC's Topic 3 research, we suggest additional research attention on reducing such community vulnerabilities, particularly those that have greater risk of exposure to toxins due to their location or traditional subsistence lifeways. Research on what drives vulnerability and how communities can build adaptive capacity and reduce vulnerability would support these EPA goals.
- **Research on Public Participation:** We acknowledge that SHC's community-based work is designed to run through regional partners, however, more research that identifies mechanisms to enhance local participation to reduce vulnerability would fit well within Topic 3 of the SHC program. Engaging a broad array of partners also involves making sure SHC research on vulnerable communities, the relationship between ecosystem services and human wellbeing, and the R2R2R process is more accessible to communities and decision-makers (beyond peer-reviewed journals and technical reports). This will help support EPA and ORD goals of supporting community-driven problem solving through integrating decision support tools and processes.
- **Workforce Development:** ORD's Goal 3 focuses on enhancing the ORD workforce. While the SHC StRAP is more focused on research design, building a skilled workforce to address community vulnerability and resilience is integral to achieving successful outcomes and supporting EPA and ORD priorities. Engaging professionals experienced in environmental impact assessment (National Environmental Policy Act of 1969), social impact assessment, and health impact assessment frameworks would ensure a more comprehensive process to expand the current focus on case studies.

## Recommendations

The subcommittee offers these three recommendations to capitalize on efforts to respond to Agency priorities.

**Recommendation 1a.1**: In order to more directly address EPA Agency priorities regarding contamination prevention, articulate more clearly in the StRAP how research addresses *prevention* as part of the effort to build community resilience in the context of contaminated sites.

*EPA Response: The StRAP includes two research areas that directly address the prevention of contaminated sites: Research Area 7 and Research Area 8. RA-7 is about taking a lifecycle approach to manufacturing; i.e., a "cradle to grave" evaluation of waste reduction or elimination. RA-8 is about research on the beneficial re-use of waste materials, including the generation of energy. Both research areas should result in less waste being landfilled, leading to the prevention of community contamination. In addition, the direct purpose of Research Area 10 is to provide information and resources for communities to use in their resilience planning to prevent events from having consequential effects on the environment and health of communities. RA-10 includes research to identify and map community assets and vulnerabilities, characterize and address potential environmental stressors and cumulative health impacts, building community capacity, and characterizing and mitigating potential risks related to contaminated sites in the context of natural disasters and extreme events. The StRAP has been modified in response to this recommendation, and further detailed information on products related to prevention will be available to the BOSC at forthcoming meetings, which will address specific products and research implementation.*

**Recommendation 1a.2**: Create systems or platforms for program and regional offices, states, and other partners to acknowledge where and how research outputs have made a material difference in publicly visible projects (including work on sites beyond EPA jurisdiction) to respond to the EPA priority of shared governance and collaboration.

*EPA Response: SHC has an intranet site that facilitates the exchange of information for EPA's program and regional offices. The site lists each of SHC's research deliverables so that our partners can review the results and apply them to their respective offices and for SHC to determine if the research has met their needs. Each year, ORD surveys a random selection of the EPA program and regional user community to ascertain if the research has met their needs and if it has made a material difference in their programs. SHC also conducts periodic webinars that describe the research and how it relates to the needs of EPA programs and regions, states, tribes, and other stakeholders. ORD's external internet site is a place where SHC communicates its impact through newsletter stories and blogs. In addition, SHC is working on the Regional Sustainability and Environmental Sciences (RESES) internet site (https://www.epa.gov/research/regional-sustainability-and-environmental-sciences-research-program-reses) to communicate the impact of RESES projects in local communities.*

**Recommendation 1a.3:** Enhance EPA and ORD goals of workforce development by engaging professionals with experience in environmental impact assessment, social impact assessment, and health impact assessment to ensure a comprehensive resilience research process.

*EPA Response: We agree with the importance of this recommendation, noting that the SHC program is engaging professionals in environmental impact assessments, social impact assessments, and the use of HIA in decision-making. Understanding the social dimensions of reducing risk at contaminated sites is just as important as the science and engineering elements of site remediation and restoration. While researchers attend professional conferences and network with external individuals, we plan to expand our engagement and relationships with professionals in these important areas.*

## Charge Question 1b

> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

**Narrative**

The BOSC SHC subcommittee agrees that SHC developed the StRAP objectives in direct response to needs identified by partners through an extensive engagement process that included multiple interactions and a process of coordinated engagement with SHC and its national and regional partners. The outputs are articulated to show how SHC's research activities will advance the development of solutions to address those issues directly.

Based on the materials provided to the subcommittee and the presentations at the face-to-face meeting, it appears that a robust process of engagement took place to incorporate partner needs. In the StRAP, the needs of several partners and regions appear to be well represented. Representatives from Region 3 noted their appreciation for the listening and engagement by SHC that will increase the likelihood of buy-in from other partners and they stated that the StRAP represents states' needs as well. Representatives

from other Agency partners complemented SHC's tool development and overall collaborative relationships to help address EPA-wide goals by linking efforts. The StRAP acknowledges the need for partnership with the Federal Emergency Management Agency (FEMA) (p.3) and the related agreement to work together should be an asset to addressing disasters and extreme weather events and their implications for contaminated sites, etc.

We recognize that ORD must balance its available resources against what is likely an extensive list of additional issues that partners may have identified. However, the subcommittee is not presented with information about how prioritization of issues occurs and what the universe of partner priorities contains. We are not questioning the selection of research needs, but instead identifying that the BOSC SHC subcommittee has no information to review for the priority setting process for research needs included in the StRAP and does not have full information on the needs of all regions, states, and tribes.

SHC may find ways to address more issues by exploring the potential for collaboration with partners in academia or other agencies in order to address important problem statements not able to be addressed due to limited resources or the need for specialization in a topical field external to EPA. More of this is included in the discussion on innovation.

**Strengths**

- SHC did a great job through multiple channels reaching out to partners including regional offices, program offices, ECOS, the Association of State and Territorial Health Officials (ASTHO), and other local/state partners. Based on the presentations by Region 3 at the meeting, it is clear that SHC is working closely with some cities and hearing community needs.
- We appreciate the intentional inclusion of "vulnerable groups" (e.g., children, elderly, minority communities, etc.) in research considerations and feels that this is a very important addition. Susceptible and vulnerable subgroups are more likely to be affected by contaminated sites because of physical proximity, immature physiological systems (e.g., children), and existing medical conditions. In addition, social, economic or emotional stress may amplify the effects of toxins. Furthermore, there are several factors which predispose individuals to greater vulnerability after exposure to toxins (biological agents) and toxicants (chemicals) from the site. Vulnerable populations are also marginalized with limited social and political capital, and many have language barriers that make these individuals and communities less able to advocate for themselves.
- Efforts related to establishing a science-based landfill post-closure time horizon are clearly in response to partner needs for guidance and efforts related to understanding the phenomena of 'hot landfills' and management of bioreactor landfills.
- The U.S. Environmentally-Extended Input-Output Model (USEEIO) and updates to the Solid Waste Facts and Figures report to include classification by generator North American Industry Classification System (NAICS) code will provide states and other partners information to more proactively pursue source reduction and reuse strategies. Such analyses are critical for providing a holistic approach to materials management across the full supply chain and provide information that is a hedge against unintended consequences. The USEEIO model has been applied to a range of research questions, including sustainable purchasing and supply chain management decisions and by users that include private and public sector organizations and universities. We note that in the future it would be helpful for partners to have the Solid Waste Facts and Figures report data files as accessible, machine readable formats (e.g., csv).

**Suggestions**

While we find the StRAP to be generally responsive to partner needs, we offer several suggestions for consideration.

- **Clarity on Partner Research Needs**: We recommend more detail in the StRAP on state recommendations to know how well this outreach is represented in the StRAP (e.g., how many state-suggested research topics have been accepted? Where did state recommendations fit in the research priorities?). Similarly, tribes are mentioned, but it is not explicit what the tribe needs are and how well their needs are represented. It would be helpful to get a better understanding of how specific needs of different tribes are considered as each has a unique geography and culture as well as site characteristics and nature of contamination. It would also be helpful for the StRAP to include increased clarity on the process by which the research activities were prioritized from among all the partner-identified needs. While it does appear that many Agency partners, regions, and states were engaged in the StRAP development process, it is not clear about the involvement of all states and regions. Engagement with local governments and local partner needs identification is not always clearly and explicitly captured in the StRAP.
- **Definition of Community Partner**: It would be helpful to provide a clearer definition of *community* in the StRAP. In many cases, there are multiple communities within a geographic area of focus. Much of the exposure potential is very local and likely to be in cities. It is clear that SHC reached out to many non-federal partners such as ECOS, the American Public Health Association (APHA), the American Psychological Association (APA), ASTHO, and the Associate of State and Territorial Solid Waste Management Officials (ASTSWMO). In the future it may be helpful to reach out to more municipal-level partners such as the International Council for Local Environmental Initiatives (ICLEI), International City Managers Association (ICMA), National League of Cities (NLC), and the Urban Sustainability Directors Network.
- **Environmental Justice**: There is an opportunity to engage with local environmental justice (EJ) organizations. SHC and on-the-ground research partners should explore mechanisms to identify EJ partners in affected communities. Determining community needs goes beyond engagement with national organizations such as APHA and ASTHO. While these organizations can provide important insights, direct engagement with community members who live in close proximity to contaminated sites and use resources that may be directly affected would provide valuable perspective. An approach based on SHC's Partner Alliance and Coordination Teams (PACTs) that engages communities directly and gathers feedback in a systematic fashion could inform ORD's objectives. This is especially needed with EPA's greater focus on environmental justice.
- **Partner Engagement:** Following principles of community engagement (e.g., building relationships from the ground up versus top down) to maintain the trust initiated or built to date, and of community-based participatory research will help continue to ensure research priorities are based on local issues and needs identified by states and regions. Along with their partners, SHC staff do the important work of understanding the needs of end users and translating research for partner communities. Through partnerships with the regional offices, it may be possible to engage more explicitly and more frequently with local communities given that the regions perform or monitor work conducted at the local level and can therefore best identify needs and concerns, collect data, etc. The Cultural Broker approach referenced by FEMA may be a useful partnership model to explore:
  - *"Culture Brokers for Disaster Preparedness are people with local knowledge and the trust of community members. They are capable of bridging gaps, are willing to help, and would be trained to use the four Guiding Principles to enhance local levels of preparedness. Recruiting these individuals can help outside organizations and local communities connect, build trust,*

*and share knowledge. Such a methodology has been proven effective in educational, medical, and public health environments…"*[10]

- **Communications and Social Media:** We encourage SHC to engage experts in communications (print and electronic media, social media) and the social sciences to inform research on best practices for culturally appropriate follow-up opportunities to the regions, states, and tribes to provide input on the StRAP, even if some of their specific requests (localized needs) are not among the highest priorities for implementation of the StRAP in 2019–2022. Research Area 11 of the StRAP highlights the management plan for the ROE indicators and website. Public access to this information and readily understandable "abstracts" written in plain language could facilitate interaction to better respond to local needs.
- **Engagement Metrics:** Communities (e.g., cities, tribes, neighborhoods) are most affected by contamination, but are rarely leading the remediation. SHC should explore working with regional partners to define a metric to determine how well they are working with their local communities to measure success of these research program areas. The approach to remediation may be improved with a robust community engagement process, particularly if the community is empowered to actively participate in the process and assumes a high level of ownership in the process.
- **Flexibility for States**: Invitations to states to participate in Research Area Coordination Teams (RACTs) require a significant time commitment (e.g., 10% of a staff person's time over three months). States could use more flexibility (such as a one-day meeting) or other arrangements that would be more palatable. In general, SHC should consider increasing the flexibility of participation from states.
- **Uniform Reporting**: SHC could explore a national uniform reporting system for contaminated sites so that site contamination information can be available to partners at all levels of government. With better and more systematically organized data, states and communities can better leverage their resources to support remediation of sites, especially non-CERCLA sites. This is an issue of transparency and engagement.
- **Modeling**: The USEEIO can provide powerful analysis for those skilled in life-cycle analysis (LCA). SHC should use it to develop accessible analysis products to empower a wider set of practitioners to understand and communicate the full environmental burden of different consumption choices. We agree that the model should be further extended, e.g., by developing models for each state and linking to global models as well. There is also potential to integrate data on physical flows of materials and to integrate tracking of waste, recycling and reuse. SHC should be transparent in regard to certain limitations of input/output (I/O) LCA and the utility of process LCA in certain circumstances.
- **Potential Partners:** As part of the review process, specific SHC partnership opportunities were identified by members of the BOSC SHC subcommittee:
  - Partner with the American Academy of Pediatrics and local and state health departments to obtain consistent and ongoing and comprehensive data (e.g., on children's blood levels);
  - Partner with the Centers for Disease Control and Prevention (CDC) Childhood Lead Poisoning Prevention Program for state-level data;
  - Partner with the Pediatric Environmental Health Specialty Units (PEHSU's) to help identify emerging concerns as well as to provide education and outreach;
  - Increase formal involvement with the National Institutes of Health (NIH)/National Institute of Environmental Health Sciences (NIEHS) Superfund Basic Research Program staff as well as the

.....

[10] The U.S. Federal Emergency Management Agency (FEMA). 2019. "Building Cultures of Preparedness: A report for the emergency management higher education community." Washington, DC: FEMA.

Community Outreach and Education Cores of the funded five-year academic centers (who by nature include contacts with Region I-X Agency offices, states, tribes and various non-profits); and

- The U.S. Geological Survey (USGS) has established considerable strength in monitoring for ground/ surface water contaminants, including per- and polyfluoroalkyl (PFAS), pharmaceuticals and other chemicals of emerging concern. SHC could discuss with USGS on how to combine efforts for identifying chemicals of concern, so that there are methods and experts present in the US. This identification should be combined with identifying their effect on human health and wellbeing.

## Recommendations

The subcommittee offers these three recommendations to capitalize on engagement with SHC partners.

**Recommendation 1b.1:** Clarify the definition of community in the StRAP. The SHC StRAP mentions local businesses, local delegated programs, and vulnerable communities. These entities are not explicitly included in this charge question as partners, but they are in the SHC StRAP. It would be helpful to be explicit about the role of local scale entities (e.g., neighborhoods, governments, businesses, and organizations) as partners.

*EPA Response. A community by geography is defined as a place. It is made up of the people and their environment attached to a given location: a city, a district, a neighborhood, a country. The simplest definition of community used by SHC is the place where we live. SHC will rely upon the expertise of social scientists and communication experts to engage with communities that can benefit from SHC's research. This definition has been added to the StRAP.*

**Recommendation 1b.2:** Describe in the StRAP how SHC plans to engage communications and social science experts to provide research on best practices for culturally appropriate follow-up to regions, states, tribes, and communities to ensure that research products can be understood and used by community members. Through partnerships with regions and program offices, follow principles of community engagement and community-based participatory research to ensure research priorities are based on local issues and needs identified by states and regions.

*EPA Response: The StRAP has been revised to emphasize the importance of engaging communication experts and social scientists when reaching out to communities. Specific research products have been developed in Research Area 10 to address these points. The BOSC will have the opportunity for more detailed reviews of specific products and implementation at future subcommittee meetings.*

**Recommendation 1b.3:** More clearly articulate in the StRAP the process by which partner-identified needs were prioritized.

*EPA Response: EPA program office and region, state, tribal, and other stakeholder needs were determined through a number of mechanisms. OLEM provided a detailed list of prioritized research and development needs and SHC engaged OLEM leadership to confirm their top priorities. We engaged EPA's regions and other program offices through a series of engagement webinars to identify and prioritize their research needs. Input on EPA regional priorities was coordinated through the existing Lead Region Coordination process, whereby the 10 EPA Regions routinely communicate and coordinate on issues. State needs were identified through ECOS; and tribal needs identified through ORD's Tribal Science Council. In many instances, the needs identified by one partner were similar for all partners (e.g., PFAS research) or multiple partners (e.g. a program office and several regions). SHC's primary basis for prioritizing the research needs were the following: The EPA Strategic plan, the Superfund Task Force Report, and the memorandum on environmental justice and community revitalization. Within a specific topic (e.g., contaminated sites), prioritization was based on ORD's capability (do we have the right staff?) and capacity to conduct the research within a 4-year period. The StRAP has been updated to reflect this process.*

## Charge Question 1c

Q.1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives

articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

**Narrative**

The topics, research areas, and proposed outputs contained in the StRAP are important and express clear near-term goals that are responsive to the strategic vision of the program. The research area activities are well-articulated. However, we believe the strategic vision should incorporate more longer-term horizons for research, including how climate change[11] may influence problems over time. Some research areas would benefit from greater clarity and overall, there is need for a clearer overarching framework to connect research areas and situate them within wider, longer-term, dynamic contexts. Such structure would also help guide measurements of progress during the current StRAP time frame. We offer additional suggestions to encourage more comparisons across sites and to broaden activities related to the beneficial use of non-hazardous waste streams. Developing measures of social and institutional learning will help promote resilience at multiple scales related to recovering contaminated sites and enhancing the flow of ecosystem services for human wellbeing.

**Strengths**

- Activities under each research area are well articulated for how they respond to partner-identified needs.
- Research Area 3 on Solvent Vapor Intrusion is a good example of a clearly defined research area that is written with a high degree of specificity and has well-defined research questions and outputs.
- Individually, the activities provide strong applied focus to support the practical challenges with Sustainable Materials Management.
- The SHC StRAP recognizes that environmental conditions are not static but instead are shifting. In addition to the topic related to disasters and extreme weather events, two examples of where this is done well are the Advanced Streamline-Based Ground Water Transport Model (GW Transport) and the landfill temperature management.

**Suggestions**

- **Integrated Framework**: An integrated, overarching framework such as Figure 3 near the end of the StRAP, if incorporated earlier and referred throughout, would help to illustrate how specific problem statements or outputs address broader questions of economic prosperity, ecological and public health, and community resilience and equity. Other EPA frameworks might be useful as well to help with overall structure, such as The Total Environment Framework and the Non-Hazardous Materials Management Hierarchy to respond to priority research areas that broadly serve Resource Conservation and Recovery Act (RCRA) goals. Overarching frameworks such as these can also help to identify opportunities to engage additional expertise in economic and social scientists to create comprehensive solutions.
- **More Long-Term Vision**: SHC should place a stronger emphasis on strategic long-term vision. Sustainable environmental protection will be lost without strong science to engage, inform, and

.....

[11] USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018

empower communities with the data and tools they need. Using a logic model approach or road map to describe the relationships between resources, activities, outputs, outcomes, and impacts of a research program may help to articulate the processes involved in research over the longer term rather than just short-term outputs, outcomes, and products. Logic models are learning and management tools that provide a picture of how an organization does its work and plans for short, medium, and long-range impacts. It helps everyone see what works and why. This tool links the expected outcome of a program or project to its individual activities and processes.[12]

- **Cross-Cutting Comparisons:** SHC is in a unique position to be able to look across site-specific cases in order to compare and contrast factors influencing community vulnerability, resiliency, and progress along the R2R2R pathway. Prioritizing cross-cutting research through cross-partner and interagency collaboration will help to highlight what is context specific and what is generalizable across contaminated sites, community experience, and other issues and processes of interest.
- **Broaden Waste and Materials Management Focus:** SHC should continue efforts to characterize our nation's waste stream not only in terms of the qualities of the materials themselves, but in terms of the processes and where possible the type of products or value chains that create them. LCA informs consumers, institutional buyers, and manufacturers of the impacts of their decisions related to material flows. We suggest broadening activities related to beneficial use to include non-hazardous but voluminous waste streams that lack domestic markets and other non-disposal options for end-of-life.
- **Social Learning and Resilience:** The definition of resilience used in the StRAP is robust and forward looking. One of the key terms in that definition is "learning". Social learning is an essential component of building healthy and resilient systems (including communities).[13] Incorporating ideas about multi-level, social, and institutional learning into research on resilience may well help develop process-based metrics that are critical to community revitalization and enhancing the flow of ecosystem services for human wellbeing. Measures related to how many people access the EnviroAtlas could be a simple measure of social learning at the individual scale. At the institutional scale, social learning may lead to changes in policy and management approaches based on lessons learned and the expansion of existing knowledge about complex systems.

## Recommendations

The subcommittee offers these three recommendations to capitalize on the SHC's StRAP structure and strategic vision.

**Recommendation 1c.1:** Clearly articulate a long-term vision, set of integrative research questions, and overarching framework that guides the development of specific problem statements, research needs, and outputs and illustrates how these specific research questions contribute to overall SHC research goals and questions. Open scenario planning for emerging issues, apart from specific responses to partner needs, would help to identify possible challenges before they manifest.

*EPA Response: The StRAP covers the four years (FY 19-22) of research that is designed to meet the needs of EPA program and regional offices, states, and tribes. The long-term vision of this research program is stated in the StRAP: cleaning-up of contaminated sites, preventing the contamination of sites by sustainably managing waste materials, and helping to revitalize communities from contamination and to*

.....

[12] https://www.epa.gov/risk/mira-logic-model

[13] The works of Claudia Pahl-Wostl and Reinette Biggs may be of particular use here.

*be more resilient from future environmental threats. The StRAP has been revised to clarify the long-term vision and overarching framework that guides program development.*

**Recommendation 1c.2:** Develop research capacity for more cross-cutting research to address what is context specific and what is generalizable across contaminated site R2R2R processes and community experiences. SHC is in a unique position to look across studies to understand patterns in defining success and challenges related to community engagement and resilience, contamination, and waste and materials management.

*EPA Response: SHC agrees with this recommendation and continues to emphasize cross-cutting research. For example, the SHC program includes a substantial amount of cross-cutting research as described in Research Area 9 (Benefits from Remediation, Restoration, and Revitalization) and Research Area 10 (Community-Driven Solutions). These two research areas emphasize the importance of community engagement as it relates to defining a community's needs for revitalization. In many specific research products, scientists developed plans to look across studies and provide generalized guidance that can be applied across communities.*

**Recommendation 1c.3:** Incorporate metrics or potential opportunities in planned research for assessing multi-level, social, and institutional learning that are critical to community resilience.

*EPA Response: SHC's program includes Research Area 9 and Research Area 10, Community-Driven Solutions, that emphasize multi-level, social, and institutional learning aspects of community revitalization and resilience. The specific products associated with these research areas had not been identified when SHC's BOSC sub-committee met on April 2-3, 2019. Subsequent meetings with the BOSC will delve into the details of community revitalization and resilience. More details are included below in our response to recommendation 3.1.*

## Charge Question 1d

> Q.1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

**Narrative**

EPA ORD has a long history of balancing near-term partner needs and long-term research to be ahead of critical emerging problems. We believe long-term vision is not as strong in the current StRAP and look forward to seeing how SHC is balancing funding for these two important areas. We provide the following discussion on emerging issues for SHC to consider. There will be new chemicals of concern and SHC is uniquely qualified to look for these new chemical exposure concerns. A key metric of success is how well SHC is able to identify these new chemicals and explore their effects. States are wrestling with unregulated contaminants in drinking water and have little capacity to measure and understand the potential effects or communicate risk to the public. How can SHC work with states more effectively to engage with community partners and provide them with the necessary information and tools to effectively deal with the contamination?

The suggestions below highlight several emerging issues for consideration by SHC, including expanding the range of extreme weather events to be considered, engaging in scenario planning, and exploring new pathways for material flows. The StRAP's focus on disasters and extreme weather events should be expanded to consider not only the current focus on flooding, hurricanes, heavier and more frequent precipitation events, wildfires, lightning strikes, dry and windy conditions, but also increasing heat index (air temperature and relative humidity), earlier frost, and overall unpredictability and variability associated with projected changes in climate.[14]

Due to its role serving many different stakeholders, SHC has a unique nation-wide view of issues. This perspective along with the deep expertise of its staff should equip SHC to imagine possible scenarios and anticipate future problems and the kind of solutions they will require. Collaborative scenario planning efforts could provide a creative opportunity for SHC staff to engage with other agencies and regional, state, and community partners to break out of silos, generate novel ideas, and maintain a dynamic research organization.

**Strengths**

- The StRAP recognizes the potential for more disasters and extreme weather events. Topic 2 on Waste and Sustainable Materials Management research does a good job of prioritizing areas of greatest concern, especially around dealing with responses to acute issues related to the management of landfills. Meanwhile, efforts focused on LCA are a good indicator that SHC is taking a systematic view of material flows through the economy in a way that enables answering questions around options for minimizing environmental damage and threats to human health through material substitution and other potential solutions over longer time frames.
- The development of LCA-based resources provides foundational materials for comprehensive view of material management questions spanning the goals of the program to protect human health and the environment from the hazards of waste disposal, conserve energy and natural resources by recycling and recovery, and reducing and eliminating waste.

**Suggestions**

- **Class-Based Approach**: We encourage incorporation of a chemical class-based approach for PFAS compounds. A simple organofluorine measurement may need to be explored as an output. Simple test methods at sites must be an output due to the broad extent of contaminated sites both known and unknown.
- **Water Treatment and PFAS**: Greater research focus is needed on the role of other water treatment processes (e.g., ozone, ultraviolet [UV]) in changing parent PFAS and degradation compounds. Similarly, PFAS in community drinking water sources ultimately ends up in the sanitary system and this sewage sludge may be land applied. This application is typically on land growing non-human food crops. It is not clear that SHC is researching the potential for this PFAS pathway.
- **Lead**: Greater emphasis is needed on relative source contribution of water to blood lead levels. Despite EPA's previous research on this topic using current models (e.g., Stochastic Human Exposure and Dose Simulation-Integrated Exposure Uptake Biokinetic Model, or SHEDS-IEUBK)

.....

[14] **USGCRP**, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018

questions about water contamination continue to arise in communities. Increased community emphasis on mitigating lead exposure from drinking water may be diverting attention and resources away from better characterized sources of exposure such as paint and dust as well as consumer and cultural products. States need better tools and data to drive public health interventions and allocate limited resources.

- **Measurement of Unregulated Contaminants**: There is a growing need for measurement approaches and tools for unregulated mobile contaminants, those that are water soluble and pass through traditional drinking water treatment systems.
- **Infiltration vs. Vapor Intrusion (VI)**: Some cities are infiltrating stormwater through green infrastructure projects as an adaptation tool due to increased precipitation. Brownfield redevelopment at VI sites often leave some contaminated soil or groundwater. There should be a role for SHC to support research and information dissemination to the city planning level about contaminated sites with volatiles and balancing stormwater infiltration with concerns about migrating contamination. Very few local governments have the expertise to evaluate this or the funding to perform the sampling and study to understand the site hydrogeology. SHC should support uniform data and access including an inventory of state sites so these data are available to communities and local planners.
- **Exposome Research:** The exposome represents all exposures experienced by an individual during their lifetime. Registered chemicals currently number in the tens-of-thousands, and therefore comprise a significant portion of the human exposome. To date, quantitative monitoring methods have been developed for only a small fraction of registered chemicals. Novel approaches are therefore needed to efficiently characterize thousands of additional analytes in both environmental and biological samples[15]. SHC may want to include exposome research more explicitly in its StRAP. This may be included in the total environment approach.
- **Contaminant Migration into Storm and Sanitary Systems**: SHC should also recognize the role of LUST sites in urban areas and the migration of contamination into the right of way where water mains and sanitary and stormwater pipes are located. Water main joints may be compromised when placed in contact with petroleum compounds and sanitary and stormwater pipes are not leak proof so contamination may migrate into these pipes and carry contamination untreated to surface water. It is not clear that many communities are recognizing this risk and the opportunity for contamination to enter ground and surface waters. There may be a role for SHC to raise awareness and provide tools and technical assistance in dealing with these challenges.
- **Life Cycle Cost Analysis**: SHC should explore using LCA for materials technology and innovation to answer questions around how to get desirable properties of materials to enable more cost-effective reuse and recycling. LCA can be used to better identify sources of contaminants and support research on how to efficiently reduce these contaminants in the environment through market incentives. LCA can also be used to determine how the systems must change in order to support innovations in materials that are generated. For example, how does the current solid waste management system need to change to take advantages of the full potential benefits of movement to bio-based plastics and development of circular materials flows?
- **Circular Economy for Materials Management:** Recent dramatic changes to international markets for recyclable material highlight a need for research to support the development of domestic markets and a more "circular economy." SHC provided examples of where its research has

.....

[15] Sobus, J., J. Rager, AND M. Strynar. Developing Non-Targeted Measurement Methods to Characterize the Human Exposome. 2015 Assn of Public Health Laboratories, Indianapolis, IN, May 18 - 21, 2015. https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=311892&Lab=NERL

supported safe and novel re-use options for special waste types from power plants and other industries. A similar approach is now needed to create new pathways for material flows that have been recently disrupted. These and other critical research relating to the technologies and materials innovations for cost-effective reuse and recycling, underscore the need for research that can address circular economy issues at a systems level and a holistic approach that integrates physical, natural and social sciences, business, economics, and engineering. For example, how does the current solid waste management system need to change to take advantages of the full potential benefits of movement to bio-based plastics and development of circular materials flows? What research is needed to avoid unintended outcomes related to introducing new materials into a waste management system not designed to handle it?

- **Adaptive Technology**: There is a role for SHC to support research on resource and material recovery technology that can operate on different scales and is more flexible to respond to market fluctuations.
- **Disasters and Extreme Weather Events:** In addition to disasters and severe storms, industrial processes involving the injection of wastewater into wells or the use of wells that lack adequate casing can result in groundwater contamination. Local small earthquakes related to oil and natural gas exploration and extraction (hydraulic fracturing or fracking) pose risks that compound contaminated site management and may thwart community resilience-building efforts. We encourage SHC to consider not only the pulse or acute types of disasters and extreme weather events, but also the longer-term issues that can emerge more slowly. Process-based indicators may resolve some of the tension between measuring short and long-term outcomes and can reflect engagement strategies related to ecosystem services cascades and social learning. Baseline data are not as useful because the climate change is shifting the baselines and current data are not predictive of future ecosystem status. Orienting around future goals rather than past expectations may be useful.
- **Ecosystem Services and Community Wellbeing:** Ecosystem benefits can be complicated to calculate as they depend on the community or people they are serving. There is an inherent assumption that increasing ecosystem goods and services leads to increased human wellbeing. However, more investigation in line with broader scientific inquiry should focus on the relationships between services and wellbeing, recognizing that the flow and ability to capture benefits across populations and contexts may be inequitable. We suggest incorporating recent advances in conceptual understanding and applied uses of ecosystem services that recognize that benefits and values emerge from a cascading process, which is mitigated at each step by social and cultural factors resulting in inequitable access to ecosystem service benefits within communities. We look forward to seeing metrics on the flow and value (or lack thereof) of ecosystem services for specific groups or communities along these lines in the forthcoming implementation plan.
- **Engagement:** Engagement strategies are important components of SHC's research agenda but are not themselves a focus of research. There is an opportunity here to focus research inquiry on questions of engagement and associated methods. Engaging cultural anthropologists, medical anthropologists, applied ecologists, behavioral scientists, and sociologists early on in the research process on community resiliency in the face of contamination may help to maximize consideration of human and ecological health and the engagement processes that catalyze resiliency.
- **Comparative Community Experiences with Contamination and R2R2R:** SHC is uniquely positioned to go back to communities who have been through the process of R2R2R - or are further along the process - to identify what stakeholders wish they would have known or done along the way. In other words, looking back systematically through research can illuminate areas worthy of new investigation or incorporation into new processes and technical support. Relatedly,

better understanding long-term impacts of contaminated sites and R2R2R efforts comes from long-term studies such as that on permeable reactive barriers.

## Recommendations

The subcommittee offers these three recommendations to capitalize on emerging issues.

**Recommendation 1d.1:** The SHC StRAP should expand research on measurement approaches and tools for unregulated mobile contaminants (e.g., those that are water soluble and pass through traditional drinking water treatment systems).

*EPA Response: Research on unregulated mobile (soluble) contaminates that pass through traditional drinking water treatment systems is the purview of the Safe and Sustainable Water Resources Research Program. SHC is partnering with SSWR to address issues associated with treatment of wastewater and solid waste leachate to prevent contamination of surface and groundwater with perfluorinated compounds.*

**Recommendation 1d.2:** The SHC StRAP should recognize the role of emerging forms of media as they plan for sharing results and communicating risks to communities. SHC should clarify in the StRAP how they plan to engage public and private sector researchers and practitioners in health education and risk communication to inform relevant research on best emerging practices.

*EPA Response: A section has been added to the StRAP that emphasizes the importance of translating the research results to the public and recognizes the role of emerging methods for reaching the public.*

**Recommendation 1d.3:** Broaden the types of hazards, disasters, and extreme weather events that threaten community resilience, contaminated site projects, and waste and materials management to include both acute and chronic stressors and associated increased levels of variability and uncertainty. The SHC StRAP should be explicit about the influence climate change may have on the problems across research areas and topics.

*EPA Response: The StRAP defines extreme events in a broad sense and includes: extreme weather, wildfires, earthquakes, and other acute and chronic stressors that impacts a community's ability to be sustainable. ORD's Air and Energy and Homeland Security research programs also include research plans for addressing disasters and community resilience. ORD recognizes resilience as one of the research topics cutting across multiple research programs. Some of these events, e.g., extreme weather, are likely a result of climate change.*

## Charge Question 1e

Q.1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

**Narrative**

Innovation is an important and growing tool for private and public organizations to develop new solutions and scale known solutions. SHC has a long history of developing innovative solutions to complex environmental problems. Through the Science to Achieve Results (STAR) and People, Prosperity, and

Planet (P3) Programs, EPA ORD invests in innovation at academic institutions and supports undergraduate research. EnviroAtlas is a valuable platform for facilitating access to innovative approaches. SHC's extensive LCA data could be put to highly creative use if made more fully available using innovative open access mechanisms. In previous sections, we recognize SHC engagement with many community partners to identify stakeholder needs.

Based on the information provided in the StRAP, there is an opportunity to expand the SHC innovation investments more deeply into communities. SHC should explore models using innovation funds and market-based approaches to advance community-based solutions to these identified environmental needs. This innovation funding could support expanded research on open source technology, data accessibility, citizen science, youth programs, network building, and evaluation of community engagement strategies to support EPA remediation, restoration, and revitalization programs.

**Strengths**

- SHC curates an extensive set of data that is available to the public through EnviroAtlas and other tools for research and education. This platform may provide a vehicle for drawing attention to innovative approaches and ways of visualizing data.
- The PACTs are a great venue for innovative thinking, particularly if they include external partners with direct experience with issues such as community contamination-to-revitalization processes.

**Suggestions**

- **Incentives for Community Engagement**: There is an opportunity for SHC to explore research on the role of federal (and state and local) tax incentives to promote community engagement. Many communities are using local incentives for Brownfield site remediation. These incentives focus on remediation, but not community engagement. There is a role for SHC in supporting research on the effectiveness of these engagement programs and potential federal, state, and local incentives to support research, community engagement, and remediation at orphan sites.
- **Small Grant Programs for Community Engaged Research**: Small grant programs, through program offices if not SHC itself, could be used to fund research projects where multiple stakeholders are connected and then aligned around a common problem and all agree to work together to produce a solution. This approach may be useful for areas that are priorities but lower on the funding list and could support non-traditional collaboration among universities, local governments, businesses, and neighborhoods. Market-based solutions should be explored to ensure that underserved communities and EJ communities are actively engaged in remediation and community revitalization strategies. SHC should explore research on the co-benefits of projects that engage with communities early to identify research and data needs to help with designing a remedy. There is an opportunity to take successful models like R2R2R in the Great Lakes and scale this across other EPA contaminated sites and explore ways that states and locals could use this approach or adapt this strategy for their non-CERCLA sites. SHC should explore strategies to improve the quality of community engagement and transfer of control to local communities as EPA's role diminishes post-remediation.
- **Market-Based Solutions**: SHC research programs have the potential to help scale examples of market-based solutions and incentives to adopt new technology and financing. For market-based solutions to work, there must be a clear understanding of the market and what economic conditions would support resource recovery and reuse cycles. Engaging experts in environmental economics and behavioral sciences would inform research on the potential impact of local and state incentives. Additionally, we suggest expanding research on existing federal and/or state tax

rebate incentives to engage more small businesses and larger private sector companies and laboratories, similar to achievements with electric vehicles, the Energy STAR Program, the Water Sense Program, and the National Institutes of Health (NIH) Small Business Innovation Research Program.

- **University and Youth Partnerships**: There is an opportunity for SHC to explore opportunities to further advance the EPA P3 Program by promoting programs with universities and the private sector that focus on community sustainable materials management innovation opportunities. Extending partnerships with the Student Conservation Association, which has youth and young adult programs, and AmeriCorps may be helpful for developing student research design and development programs, internships, and externships. Community-campus or community-business partnerships may be good models to explore.
- **Communications Research**: SHC should consider innovative strategies to engage with both public and private sector researchers and practitioners in health and risk communication to share results from research and work products via various forms of media, including television, online short films, webpages/internet, social media (words/phrases), and visuals (photos, pictograms, drawings) and evaluate their comparative efficacy.
- **Staff Incentives**: There is an opportunity for SHC to create incentives for their scientists to work directly with end users to inform their research. It is important that the tools developed by SHC yield successful projects that provide direct assistance to contamination-stressed communities. Land grant universities provide good examples and partners on this effort as their primary mission is to provide research-based outreach and technical assistance to communities on a variety of topics ranging from food and agricultural production to community and economic development, environmental and natural resource management and family and youth issues.
- **Open Source Technology**: There is an opportunity to broaden the investment in research programs to develop open source sampling technology so communities can engage in citizen science and assist in gathering local data such as air particulates and stormwater quantity and quality. SHC should explore the concept of "Government-as-a-Platform" for developing innovative strategies for empowering direct and indirect partners with data. Small challenge grants and larger prizes could help to drive such programs. Evaluation outcomes include not only the technology but community education and linkages with Science, Technology, Engineering, and Mathematics (STEM) or Science, Technology, Engineering, Arts, and Mathematics (STEAM) programs in K-12 education.
- **Innovation Metrics**: In future BOSC SHC subcommittee meetings, it would be helpful to have more information on current innovation investments and the metrics used to judge their success.

## Recommendations

subcommittee offers these three recommendations to capitalize on innovations and market-based approaches.

**Recommendation 1e.1:** Explore through research local and state incentive programs as well as existing federal and/or state tax rebate incentives on their ability to engage more small businesses and larger private sector companies and laboratories as well as community groups in the design of remediation technologies and community revitalization strategies. Experts in environmental economics and behavioral sciences may be helpful in supporting this endeavor.

*EPA Response: Thank you for the suggestions. We agree that federal and state incentive programs can be important in spawning innovation to solve emerging environmental problems. Within SHC, we fund the P3 (People, Prosperity & Planet) program, a competition among universities to develop innovative solutions to world-wide environmental problems. In addition, SHC's RESES program, which funds ORD-Regional science collaborations, has added Opportunity Zones to its solicitation as a potential target for applied research.*

**Recommendation 1e.2:** Engage students and researchers from a diversity of schools and disciplines, including design, planning, law, business, natural and social sciences, humanities, and the arts using ORD data to create business models and or innovative product designs that maximize material reuse and minimize environmental risk and burden. Similarly, consider engaging with the Student Conservation Association and AmeriCorps to develop student research design and development programs, internships, and externships to expand on the P3 model.

*EPA Response: Thank you for the suggestions. We will consider broadening the P3 solicitation to include organizations like the Student Conservation Association and AmeriCorps.*

**Recommendation 1e.3:** Develop open source sampling technology for citizen science to help gather local environmental data and other innovative strategies to empower direct and indirect partners with data.

*EPA Response: The current and future SHC program includes the use of open-source sampling technology. One example is the Regional Sustainability and Environmental Sciences (RESES) project, Kansas City Transportation and Local-Scale Air Quality Study, or KC-TRAQS. This project features a portable air quality monitor, the AirMapper, which citizens of the Argentine community in Kansas City, KS use to collect particulate matter measurements of their own, which could then be compared to data from stationary PM monitors around the neighborhood. Another RESES project begun in 2018, "Community Participation in Classifying Odors from Air Pollution Emissions," has developed an odor-tracking mobile phone app that allows residents in several pilot communities across multiple Regions to record observations on the nature of unpleasant odors that cause concern about possible air pollutant exposure among residents; the observations then feed into existing online complaint-tracking systems supported by state and local entities.*

## Charge Question 2

Q.2. SHC's StRAP is set-up as a series of problem statements with solutions (labeled as Outputs). This is the approach we have used to address partner-identified needs (see Q.1b above). Is this

approach helpful in identifying research that is likely to meet the needs of EPA's program and regional offices? What about the needs of the states and tribes?

**Narrative**

The approach of paired problem statements and outputs is good for ensuring that SHC program research is responsive to the specific needs of ORD clients and partners. There are good examples throughout the StRAP where problem statements and outputs articulate helpful questions and actionable solutions. The lingering question is how to look at what is known and what needs to be known about a specific problem (such as a specific contaminated site or contaminant) and how to communicate that knowledge to key partners and affected communities to address the challenge. We offer suggestions on how to more effectively bridge from problems to helpful outputs by giving more attention to implementation plans and research processes, seeking more coherence across problem-output sets, and adding greater specificity in output details. In general, we feel there could be more documentation of the needs of tribes and communities specifically, though we recognize the key role of EPA regions in making these connections.

**Strengths**

- The problem statements often effectively identify the needs of partners and lay out the key issues in need of research and the outputs highlight proposed solutions.
- The mixed methods evaluation elements of Regional Sustainability and Environmental Sciences Research Program (RESES) is a great example of the capabilities of SHC to evaluate its own outputs.
- The research focus areas on Volatilization to Indoor Air and PFAS are examples where problem statements articulate clear challenges in many communities where there is often no expertise in the local government or non-governmental organization (NGO) community. The Volatilization to Indoor Air research theme is well-defined, more specific, and actionable. PFAS research is much needed and important and SHC is asking the right questions. Problem statements on lead are important and related outputs conducted in partnership with other researchers and organizations are likely to be helpful in reducing lead exposures in populations.

**Suggestions**

- **Implementation Plan**: We look forward to seeing the implementation plan in progress by SHC to identify how the problems identified in the StRAP will be addressed. More details on how planned steps and processes will help to achieve associated outputs would be helpful as some of the current problems and outputs are somewhat vague. Such information will help to articulate how SHC research links to specific EPA goals for the retirement of sites and community engagement. Metrics to evaluate the use and success of outputs, perhaps organized as a taxonomy of end products, will help to describe components necessary to address partner-identified needs.
- **More on Process**: We found the terminology inherent in the structure of the StRAP to be a bit problematic, specifically the term "Output" as the research response to the problem statements. In many cases, the outputs are reports, rather than benchmarks to indicate progress on a problem, such as reduced vulnerability. Thus, while the outputs are readily achievable, this doesn't mean that the overarching goals of reducing vulnerability will be achieved. Furthermore, the focus on outputs seems to skip over the process of research. Having an inclusive, robust process is as important as having a good outcome. Our suggestion is to consider including sections or at least information on participation, process, and research methods with progress along those paths reportable as outcomes. Better words for these sections of the StRAP might be "objective"

or “strategy” or “method.” Following a logic model framework, such as the health education framework or other approaches, will help pay attention to process and impact data as much as solutions (outputs, outcomes).

- **Increase Coherence Across Problems and Outputs**: Currently, problem areas stand alone and are addressed iteratively with specific solutions to individual problems. This lack of cohesion among and across research areas may lead to a lack of focus on emerging needs (see Charge Question 1d). An overarching framework or effort to synthesize and connect research areas would be useful and could help to leverage outputs for other related problems to build knowledge across SHC efforts (and ORD more broadly).
- **Organizing Outputs**: Problem evaluation approaches may help to identify patterns in conditions and approaches that lead to the most effective solutions across varied problems. The field of Information Architecture may offer useful approaches for organizing outputs. Flexible tag-based systems can be used to find intersections and common threads across seemingly disparate activities. For example, tags could be used to identify all outputs related to a particular statute, contaminant, population, or existing research that is being built upon. This approach may help to summarize efforts across common themes and communicate how the whole of SHC’s efforts is greater than the sum of its parts.
- **Problem and Output Specificity**: One of the key limitations in many of the problems statements is the lack of a clearly articulated problem that the output is seeking to address. For example, "technical support at contaminated sites", does not describe what gap or deficiencies in technical assistance currently exist. Specific metrics for measuring delivery of technical assistance to states, regions, tribes and communities would be useful. More specific taxonomy of end products (e.g., tool, data, database, recommendations, etc.) may be more helpful in describing all components necessary to comprehensively solve partner identified needs.
- **Tribes**: It would be useful to see greater documentation of the needs of tribes. We acknowledge that very specific needs and concerns may not be ranked among the highest priorities for research conducted in a given period and that EPA regions have a key role to play in working with tribes. However, in response to this charge question that asks specifically about tribes, we feel this is an under-emphasized area within the StRAP.

## Recommendations

The subcommittee offers these two recommendations to capitalize on the problem-output approach used in the StRAP.

**Recommendation 2.1:** Develop a tracking system to provide more coherence across problem-output packages and to identify activities related to particular statutes, contaminants, populations, or research efforts. This would help to more clearly articulate the research process between problems, outputs and products.

*EPA Response: Thank you for the recommendation. EPA and ORD are prioritizing LEAN management across programmatic management and research activities, and we will take this recommendation forward into the implementation phases of the SHC and other research portfolios.*

**Recommendation 2.2:** Document the needs of tribes more thoroughly in the StRAP.

*EPA Response: The StRAP has been revised to more thoroughly describe the needs of the tribes. SHC's link to identifying tribal needs is through the EPA Tribal Science Council. SHC also engaged in a formal Tribal Consultation in 2019, focusing discussions on opportunities to better address tribal needs through the EnviroAtlas.*

## Charge Question 3

> Q.3. At the request of EPA's Regions, we have included the impact of natural disasters (e.g., severe weather, wildfires) in research areas 9 and 10. The focus is on how these types of disasters impact contaminated site remediation and restoration and community resilience. What suggestions does the subcommittee have for making this research more efficacious?

**Narrative**

Awareness of the implications of natural hazards and disasters on contaminated sites, landfills, and other sources of environment contaminants is the first step in helping communities prepare for and respond to a unique set of challenges posed by climate change[16]. Awareness of the presence of sites that may be at risk from disasters and extreme weather events may also further motivate general preparedness and resilience-building efforts when those threat multipliers are evident. We suggest expanding this focus throughout the SHC research agenda, connecting to longstanding work on the Disaster Management Cycle to incorporate more research and data access on prevention and preparedness, and working across agencies to share information and map cross-boundary risks. We draw attention to the importance of terminology, as while hazards may be natural, disasters are not purely natural as they involve social, built, economic, political, and natural processes. We highlight the importance of ensuring that research on disasters and extreme weather events related to CERCLA sites flows onward to those responsible for other types of contaminated sites. Finally, we urge recognition of cultural dimensions of resilience and the importance of cultural differences in community-oriented research.

.....

[16] **USGCRP**, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018

**Strengths**

- We applaud SHC for recognizing the role of natural hazards, disasters, and extreme weather events and their impacts on vulnerable populations and community resilience, particularly related to contaminated sites. SHC's definition of resilience is robust and in line with broader contemporary scientific thinking.
- EnviroAtlas is a powerful asset for revealing potential risks to a diverse array of partners and communities.

**Suggestions**

- **Mainstream Disasters and Extreme Weather Events**: Given the widespread implications of disasters and extreme weather events across the SHC research agenda, we suggest using this as a cross-cutting theme, along with resilience, throughout the StRAP (not just in Topic 3). For example, research into the characterization of built-environment materials banks can explore what-if scenarios for the generation of disaster debris from extreme weather events. The emerging set of risks presented by the changing environmental conditions are having and will continue to have both acute and chronic impacts on contaminated sites and contaminant flows, waste and materials management, and community resilience. Vulnerability assessments should emphasize risks presented by changing environmental conditions and should include climate projections. In terms of overall strategic vision, there should be more attention to adaptive management throughout the document, particularly given the dynamic nature of contamination and materials management in the face of a rapidly changing climate. This would include considering how rising temperatures, increasing unpredictability of weather, long term changes as well as acute shifts, and more disasters and extreme weather events will affect all aspects of the program. Recent EPA involvement in research and reporting on disaster debris is a good example of supporting important cross-cutting strategies.
- **Disaster Management Cycle**: We encourage SHC to explore connections between the R2R2R process and the Disaster Management Cycle. The StRAP should articulate with greater specificity how prevention and preparedness are addressed through the R2R2R process. Agency priorities strongly highlight prevention and preparedness. We offer the figure below as one possible way to begin to visualize these relationships. Building community resilience through the remediation, restoration, and revitalization process likely includes attention to prevention of and preparedness for further or renewed contamination, particularly given the compounding effects of natural hazards and extreme weather events.

**Integrating Contamination Management with Disaster Management and Remediation to Restoration to Community Revitalization (R2R2R) as an Iterative Cycle**


- **Working Across Agencies**: We encourage SHC to be more explicit about how SHC is working across agencies (e.g., FEMA, the National Oceanic and Atmospheric Association [NOAA], the U.S. Department of Health and Human Services [HHS], the Agency for Toxic Substances and Disease Registry [ATSDR], Homeland Security) to support community resilience and to avoid duplicative efforts. It is important that relevant outputs from Research Areas 9 and 10 be made known to administrators of the cross-agency U.S. Climate Resilience Toolkit. Working in collaboration with FEMA and other agencies to ensure maps are an accurate representation of flood risk promotes transfer of the best available science.
- **Cross-Boundary Issues and Mapping**: Goal 5 of the Superfund recommendations is about key stakeholders and community visioning. When extreme weather events, disasters, and changing climate trajectories occur at contaminated sites, the cross-boundary and multi-jurisdictional aspects of management become even more complex. In the SHC StRAP, we recommend incorporating additional research attention to cross-boundary risk management and preparedness arrangements across multiple jurisdictional settings as they relate to contaminated sites. The U.S. Forest Service (USFS) current research on cross-boundary wildfire risk transmission and governance might be a useful corrolary.[17] EnviroAtlas may help partners map critical sites and contamination pathways. Linking data collections within EnviroAtlas may help to reveal the intersection of identified sites that may have unique challenges and potential risks from flooding, wildfire, and other hazards and extreme weather events. Asset mapping is another key to community recovery and revitalization post-contamination, as outlined in Research Area 10. If additional resources on asset mapping are needed for SHC and partners, consider Purdue University's Center for Regional Development's asset mapping resources[18] as an example of numerous similar databases and programs managed by U.S. Universities.

.....

[17] The US Forest Service's current work on cross-boundary/trans-boundary wildfire risk governance could be useful for ideas in this arena (https://www.fs.fed.us/rmrs/groups/co-managment-fire-risk-transmission-comfrt-collaborative-approach-wildfire-risk-reduction).

[18] Lionel J. "Bo" Beaulieu is a national expert in asset mapping and community development and is the director of Purdue University's Center for Regional Development. There are two presentations on their website https://www.pcrd.purdue.edu/index.php under media and presentations.

- **Inform Beyond-CERCLA Contaminated Site Management**: We encourage SHC to evaluate mechanisms that ensure work on natural hazards, disasters, and extreme weather events on CERCLA sites flows onward to inform management of other contaminated sites, such as waste lagoons of concentrated animal feeding operations, coal ash ponds at existing power plants, nuclear power plant spent waste fuel rod sites, and other state and locally regulated sites.
- **Cultural Resilience**: Disasters do more than affect health and property, they can have impacts such as stigmatization and long-term community identity impacts. Research suggests that cultural differences can influence disaster response and recovery.[19] By incorporating research attention on cultural resilience, place attachment, and intergenerational transfer of knowledge within communities, SHC may gain critical insights into factors enabling or constraining success along the community R2R2R pathway.

## Recommendations

The subcommittee offers these four recommendations to capitalize on SHC's focus on how disasters impact contaminated site remediation, restoration, and revitalization, and through these efforts, community resilience.

**Recommendation 3.1:** In the SHC StRAP, more clearly articulate how Topic 3 research addresses contamination prevention and preparedness, particularly in the face of extreme weather events and disasters that may further or renew contamination.

*EPA Response: The description of Topic 3 has been updated in the StRAP to provide further clarification. SHC will identify critical information and develop approaches to support communities in assessing their vulnerabilities to extreme weather events and other disasters, especially for those events that might lead to renewed contamination. Approaches include mapping, metrics, and methods that consider the changing conditions to the natural, built, and social environments (including ecosystem services) that will affect resilience to natural hazards and community health and well-being. Identifying expected impacts will require using forecasts of future changes in weather and climate that lead to chronic conditions and hazardous events. Additional research will examine how changes to stressors anticipated in the future, such as increased flooding, prolonged drought, and extreme heat, can lead to cascading shocks to communities through infrastructure failure, heat- and flood-related deaths, property and crop damage, and other outcomes.*

**Recommendation 3.2:** In the SHC StRAP, we recommend incorporating additional research attention to cross-boundary risk management and preparedness arrangements across multiple jurisdictional settings as they relate to contaminated sites. When extreme weather events, disasters, and changing climate trajectories occur at contaminated sites, the cross-boundary and multi-jurisdictional aspects of management become even more complex. EnviroAtlas may help partners map critical sites and contamination pathways.

.....

[19]Clarke, H.E. and B. Mayer 2017. Community Recovery Following the Deepwater Horizon Oil Spill: Toward a Theory of Cultural Resilience. Society & Natural Resources, 30(2):129-144; Picou, J.S. 2000. The 'Talking Circle' as Sociological Practice: Cultural Transformation of Chronic Disaster Impacts. Sociological Practice, 2(2):77–97; Dyer, C.L. 1993. Tradition Loss as Secondary Disaster: Long-term Cultural Impacts of the Exxon Valdez Oil Spill. Sociological Spectrum, 13(1):65–88. https://doi.org/10.1080/02732173.1993.9982017; and The U.S. Federal Emergency Management Agency (FEMA). 2019. "Building Cultures of Preparedness: A report for the emergency management higher education community." Washington, DC: FEMA.)

*EPA Response: SHC plans to use the EnviroAtlas as a tool to address cross-boundary issues in assessing impacts from contaminated sites impacted by natural disasters. We acknowledge that cross-boundary issues involving differing levels of governance can compound the response, as do legal restrictions on certain types of data from contaminated sites. This is an area of high priority to EPA regions and has been the topic of Regional Sustainability and Environmental Sciences (RESES) projects.*

**Recommendation 3.3:** The SHC StRAP should clarify how research on disasters and extreme weather events related to CERCLA sites will flow onward to inform management of other non-CERCLA contaminated sites.

*EPA Response: The planned SHC research is intended to help stakeholders prepare for natural hazards, identify beneficial actions, anticipate and respond to events, and evaluate the effectiveness of their actions. While CERCLA guidance requires its program managers to consider a project's vulnerability to extreme weather events, what we learn from research at Superfund sites can be applicable to other sites, such as Brownfields. The goal is for communities overall to be more resilient to adverse events, recover more quickly when they occur, and experience greater health and well-being in the long term. EPA's Office of Community Revitalization and the EPA regions emphasize the need for communities to anticipate changes in extreme weather events, evaluate how these changes will affect a community, and evaluate potential best practices for responding to extreme events.*

**Recommendation 3.4:** The SHC StRAP should recognize the role of cultural differences across local contexts in disaster response, recovery, and resilience along the community R2R2R pathway.

*EPA Response: We agree that cultural differences at the local level are important considerations in responding to remediating contaminated sites and revitalizing impacted communities, and they are specifically incorporated into research products. The StRAP has been revised to recognize these differences and the research products recently identified (Research Area Templates) include a diversity of community types to better understand these cultural differences.*

## SUMMARY LIST OF RECOMMENDATIONS

This section provides a listing in a single location of the recommendations provided earlier in the report in response to each charge question.

### Charge Question 1a. Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

- **Recommendation 1a.1**: In order to more directly address EPA Agency priorities regarding contamination prevention, articulate more clearly in the StRAP how research addresses *prevention* as part of the effort to build community resilience in the context of contaminated sites.
- **Recommendation 1a.2**: Create systems or platforms for program and regional offices, states, and other partners to acknowledge where and how research outputs have made a material difference in publicly visible projects (including work on sites beyond EPA jurisdiction) to respond to the EPA priority of shared governance and collaboration.
- **Recommendation 1a.3**: Enhance EPA and ORD goals of workforce development by engaging professionals with experience in environmental impact assessment, social impact assessment, and health impact assessment to ensure a comprehensive resilience research process.

Charge Question 1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

- **Recommendation 1b.1:** Clarify the definition of community in the StRAP. The SHC StRAP mentions local businesses, local delegated programs, and vulnerable communities. These entities are not explicitly included in this charge question as partners, but they are in the SHC StRAP. It would be helpful to be explicit about the role of local scale entities (e.g., neighborhoods, governments, businesses, and organizations) as partners.
- **Recommendation 1b.2:** Describe in the StRAP how SHC plans to engage communications and social science experts to provide research on best practices for culturally appropriate follow-up to regions, states, tribes, and communities to ensure that research products can be understood and used by community members. Through partnerships with regions and program offices, follow principles of community engagement and community-based participatory research to ensure research priorities are based on local issues and needs identified by states and regions.
- **Recommendation 1b.3:** More clearly articulate in the StRAP the process by which partner-identified needs were prioritized.

Charge Question 1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019–2022 time frame.

- **Recommendation 1c.1:** Clearly articulate a long-term vision, set of integrative research questions, and overarching framework that guides the development of specific problem statements, research needs, and outputs and illustrates how these specific research questions contribute to overall SHC research goals and questions. Open scenario planning for emerging issues, apart from specific responses to partner needs, would help to identify possible challenges before they manifest.
- **Recommendation 1c.2:** Develop research capacity for more cross-cutting research to address what is context specific and what is generalizable across contaminated site R2R2R processes and community experiences. SHC is in a unique position to look across studies to understand patterns in defining success and challenges related to community engagement and resilience, contamination, and waste and materials management.
- **Recommendation 1c.3:** Incorporate metrics or potential opportunities in planned research for assessing multi-level, social, and institutional learning that are critical to community resilience.

Charge Question 1d. Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

- **Recommendation 1d.1:** The SHC StRAP should expand research on measurement approaches and tools for unregulated mobile contaminants (e.g., those that are water soluble and pass through traditional drinking water treatment systems).
- **Recommendation 1d.2:** The SHC StRAP should recognize the role of emerging forms of media as they plan for sharing results and communicating risks to communities. SHC should clarify in the

StRAP how they plan to engage public and private sector researchers and practitioners in health education and risk communication to inform relevant research on best emerging practices.

- **Recommendation 1d.3:** Broaden the types of hazards, disasters, and extreme weather events that threaten community resilience, contaminated site projects, and waste and materials management to include both acute and chronic stressors and associated increased levels of variability and uncertainty. The SHC StRAP should be explicit about the influence climate change may have on the problems across research areas and topics.

Charge Question 1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

- **Recommendation 1e.1:** Explore through research local and state incentive programs as well as existing federal and/or state tax rebate incentives on their ability to engage more small businesses and larger private sector companies and laboratories as well as community groups in the design of remediation technologies and community revitalization strategies. Experts in environmental economics and behavioral sciences may be helpful in supporting this endeavor.
- **Recommendation 1e.2:** Engage students and researchers from a diversity of schools and disciplines, including design, planning, law, business, natural and social sciences, humanities, and the arts using ORD data to create business models and or innovative product designs that maximize material reuse and minimize environmental risk and burden. Similarly, consider engaging with the Student Conservation Association and AmeriCorps to develop student research design and development programs, internships, and externships to expand on the P3 model.
- **Recommendation 1e.3:** Develop open source sampling technology for citizen science to help gather local environmental data and other innovative strategies to empower direct and indirect partners with data.

Charge Question 2: SHC's StRAP is set-up as a series of problem statements with solutions (labeled as Outputs). This is the approach we have used to address partner-identified needs (see Q.1b above). Is this approach helpful in identifying research that is likely to meet the needs of EPA's program and regional offices? What about the needs of the states and tribes?

- **Recommendation 2.1:** Develop a tracking system to provide more coherence across problem-output packages and to identify activities related to particular statutes, contaminants, populations, or research efforts. This would help to more clearly articulate the research process between problems, outputs and products.
- **Recommendation 2.2:** Document the needs of tribes more thoroughly in the StRAP.

Charge Question 3: At the request of EPA's Regions, we have included the impact of natural disasters (e.g., severe weather, wildfires) in research areas 9 and 10. The focus is on how these types of disasters impact contaminated site remediation and restoration and community resilience. What suggestions does the subcommittee have for making this research more efficacious?

- **Recommendation 3.1:** In the SHC StRAP, more clearly articulate how Topic 3 research addresses contamination prevention and preparedness, particularly in the face of extreme weather events and disasters that may further or renew contamination.

- **Recommendation 3.2:** In the SHC StRAP, we recommend incorporating additional research attention to cross-boundary risk management and preparedness arrangements across multiple jurisdictional settings as they relate to contaminated sites. When extreme weather events, disasters, and changing climate trajectories occur at contaminated sites, the cross-boundary and multi-jurisdictional aspects of management become even more complex. EnviroAtlas may help partners map critical sites and contamination pathways.
- **Recommendation 3.3:** The SHC StRAP should clarify how research on disasters and extreme weather events related to CERCLA sites will flow onward to inform management of other non-CERCLA contaminated sites.
- **Recommendation 3.4:** The SHC StRAP should recognize the role of cultural differences across local contexts in disaster response, recovery, and resilience along the community R2R2R pathway.

## CONCLUSIONS

The SHC 2019–2022 StRAP could make a real difference in both the shorter term and in the longer term for communities of the United States. Nevertheless, we also identified specific improvements represented by the recommendations above to further improve both the finalization of the StRAP and the implementation then monitoring and evaluation of the data on process, impact, and actions (outputs, outcomes, solutions, technologies and tools). In summary, recommendations focus on better defining and/or documenting details of vulnerability reduction, prevention of contamination, the value of community and ecosystem services; broader community engagement with improved balance in regional (and thus state, tribal and county-to-local) representation; increased interagency communications and collaboration; and, acknowledging both acute and chronic extreme weather events, beyond impacts of floods and wildfires (natural or man-made).

Overall, we find the activities described in the SHC StRAP under the three topic areas to be well aligned with the goals of the ORD Strategic Plan. In addition, these activities are clearly of high importance for protecting human health and the environment from significant risks that exist related to contaminated sites, hazardous waste streams and disposal facilities, and disasters and extreme weather events.

Key themes from our review include the need to better define community partners, focus on longer-term research vision, expand research focus on understanding material streams and prevention of contamination, and build additional social science research capacity on the intersection of disasters, contamination, and vulnerable communities. The foundational science for better understanding of sustainable and healthy communities is poised to empower states and other actors to take action and avoid further increasing environmental burdens.

We thank the SHC for the opportunity to review and comment on this important national research program effort. We reviewed materials provided in advance, as well as the applications presented in panel discussions, and other interactions at the subcommittee meeting. Overall we were very impressed by the quality of research that was presented in this regard.

# APPENDIX A: MEETING AGENDA

**Environmental Protection Agency**
**Board of Scientific Counselors (BOSC)**
**Sustainable and Healthy Communities (SHC) Subcommittee**

**Meeting Agenda**
**April 2-3, 2019**
US EPA Research Triangle Park Campus, Room C-112
109 T.W. Alexander Drive, Research Triangle Park, NC 27711

| TIME | TOPIC | PRESENTER |
|---|---|---|
| **Tuesday, April 2, 2019*** | | |
| 8:00 – 8:30 | Registration | |
| 8:30 – 9:00 | Call to Order and Introductions | Courtney Flint, Chair<br>Jace Cujé, Designated Federal Officer (DFO)<br>Bruce Rodan, ORD-Associate Director for Science |
| 9:00 – 10:15 | **Overview of SHC's Strategic Research Action Plan (StRAP)**<br>• Topics, Research Areas, Outputs<br>• Partner Engagement<br>  o Office of Land and Emergency Management (OLEM)<br>  o Regions<br>  o Regional Sustainability and Environmental Sciences Research Program (RESES)<br>• BOSC Questions or Clarification and Further Questions | Mike Slimak (NPD-SHC)<br><br>Stiven Foster (OLEM)<br><br>Regina Poeske (EPA Region 3)<br>Sarah Mazur (SHC)<br><br>Subcommittee |
| 10:15 – 10:30 | Break | |
| 10:30 – 12:00 | **Topic 1: Contaminated Sites**<br>• Overview<br>• OLEM Perspective<br>• Selected Illustrations<br>  o Site Characterization and Remediation (RA2)<br>  o Chemicals of Immediate Concern (RA5)<br>  ▪ Lead (Pb)<br>  ▪ Per- and polyfluoroalkyl substances (PFAS) | Andrew Geller (Deputy-SHC)<br>Dan Powell (OLEM)<br><br>Tom Holdsworth (SHC Matrix Interface (MI))<br><br>Andrew Geller (SHC)<br>Elaine Cohen-Hubal (NERL) |

| TIME | TOPIC | PRESENTER |
|---|---|---|
| | • BOSC Questions of Clarification and Discussion | Subcommittee |
| 12:00 – 1:00 | Lunch | |
| 1:00 – 2:30 | **Topic 2: Waste and Sustainable Materials Management**<br>• Overview<br>• OLEM Perspective<br>• Selected Illustrations<br>  o Landfill Management (RA6)<br>  o Life Cycle Inventories and Methodologies (RA7)<br>• BOSC Questions of Clarification and Discussion | Andrew Geller (Deputy-SHC)<br>Barnes Johnson (Director, ORCR/OLEM)<br>Thabet Tolaymat (NRMRL)<br>Wes Ingwersen (NRMRL)<br><br>Subcommittee |
| 2:30 – 2:45 | Break | |
| 2:45 – 3:00 | Public Comments | |
| 3:00 – 4:30 | **Lab Tour**<br>• EnviroAtlas<br>• Bioaccessibility<br>• Solvent Vapor Intrusion | Anne Neale (NERL), Megan Mehaffey (NERL), Laura Jackson (NHEERL)<br>Karen Bradham (NERL)<br>John Zimmerman, Alan Williams (NERL) |
| 4:30 – 5:30 | BOSC Deliberations | Subcommittee |
| 5:30 | Wrap-Up and Adjourn** | Courtney Flint, Chair |

| **Wednesday, April 3, 2019*** | | |
|---|---|---|
| 8:30 – 9:00 | Registration | |
| 9:00 – 9:15 | Call to Order | Courtney Flint, Chair |
| 9:15 – 10:45 | **Topic 3: Healthy and Resilient Communities**<br>• Overview<br>• Program Office/Region Office Perspective<br>• Selected Illustrations<br>  o Benefits from R2R2R (RA9)<br>  o Community-Driven Solutions (RA10)<br>• BOSC Questions of Clarification and Discussion | Sarah Mazur (SHC)<br>John Thomas (Office of Community Revitalization) /Jonathan Essoka (EPA Region 3)<br><br>Joel Hoffman (NHEERL)<br>Nicolle Tulve (NERL) and Susan Julius (NCEA)<br>Subcommittee |
| 10:45 – 11:00 | Break | |

| | | |
|---|---|---|
| 11:00 – 11:30 | BOSC Open Discussion with SHC Team | Subcommittee<br>SHC Team |
| 11:30 – 12:30 | Lunch | |
| 12:30 – 3:20 | BOSC Deliberations*** | Subcommittee |
| 3:20 – 3:30 | Break | |
| 3:30 – 4:30 | BOSC's Initial Response to StRAP | Subcommittee |
| 4:30 | Wrap-Up and Adjourn | Courtney Flint, Chair<br>Jace Cujé, DFO |

* All times noted are Eastern Time and are approximate.
** Wrap-up and adjournment may occur any time following the site visits, at the discretion of the DFO and Chairs.
*** Breaks at the discretion of the chair.

# APPENDIX B: MATERIALS

## Material Provided in Advance of the Meeting

***Materials to Support the Charge Questions***

- Board of Scientific Counselors (BOSC) Sustainable and Healthy Communities (SHC) Subcommittee Meeting—April 2019; Notice of public meeting (84 *FR* 9337; March 14, 2019)
- **Tier 1 –** *most important to review*
  - SHC Strategic Research Action Plan (StRAP)
  - FY2018-FY2022 EPA Strategic Plan
  - ORD Strategic Plan 2018-2022
  - Superfund Task Force Recommendations
  - Memorandum on EPA's Environmental Justice and Community Revitalization Priorities
  - SHC Stakeholder Engagement Fact Sheet
- **Tier 2** – *additional information on research drivers*
  - 2016 State Research Needs Survey
  - SHC StRAP Topic 3 Drivers
  - EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan
  - Federal Action Plan to Reduce Childhood Lead Exposure
- **Tier 3** – *additional reading for BOSC members*
  - *Sample SHC Research*
    - EPA's Sustainability and Healthy Communities National Research Program 2018 Accomplishments
    - SHC Research Bibliography, 2016-present
    - SHC Overview Fact Sheet
  - *Innovative Programs*
    - Innovation at EPA Webpage
    - ORD's People, Prosperity and the Planet
  - *Programmatic Context*
    - U.S. EPA Sustainable Materials Management Program Strategic Plan, FY 2017-2022
    - Sustainable Materials Management: The Road Ahead
    - Great Lakes National Program Office and its authorities
      - Great Lakes Water Quality Agreement & Areas of Concern
      - Great Lakes Restoration Initiative
    - Brownfields Program

***Informational Materials***

- **Actionable Recommendation Examples**
  - 2015 BOSC EC report posted at https://www.epa.gov/sites/production/files/2016-01/documents/bosc_ec_report_draft.pdf)
  - 2012 joint SAB/BOSC EC Report posted at https://www.epa.gov/sites/production/files/2015-02/documents/120928rpt.pdf.
  - Previous Agendas, Meeting Documents and Approved Meeting Minutes from SHC Subcommittee "Past Meetings" accessible at https://www.epa.gov/bosc/sustainable-and-healthy-communities-bosc-subcommittee (right-hand column).

## Additional Material Provided During the Meeting

- National Program Director (NPD) & Deputy NPD Welcome Letter

## Additional Material Provided After the Meeting

- SHC's Tools Table
- ORD-Regions Coordinated Engagement Process Diagram