BOSC
BOARD OF SCIENTIFIC COUNSELORS

February 18, 2021

Jennifer Orme-Zavaleta, Ph.D.
Principal Deputy Assistant Administrator for Science
Office of Research and Development
U.S. Environmental Protection Agency

Dear Dr. Orme-Zavaleta:

On behalf of the Board of Scientific Counselors (BOSC), I am pleased to provide you a review report addressing charge questions posed by two of the Office of Research and Development's (ORD) six National Research Programs.

The BOSC was reconstituted in 2017 with an Executive Committee and five subcommittees aligned with each of the National Research Programs (part of the Health and Environmental Risk Assessment program is reviewed in conjunction with the Chemical Safety for Sustainability program). Two of the subcommittees, Homeland Security and Safe and Sustainable Water Resources, met in August–December 2020 culminating in an Executive Committee meeting in January 2021. This report represents the cumulative effort of the subcommittees and the Executive Committee.

We anticipate that this report will assist ORD in evaluating the strength and relevance of these two research programs and aid in guiding further course adjustments to each program. We will be happy to provide any additional information concerning the review or answers to any questions you may have, and we look forward to working with your in the future on these programs.

Sincerely,

Paul Gilman, Ph.D.
Chair, BOSC

Lucinda Johnson, Ph.D.
Vice Chair, BOSC

Cc: Bruce Rodan, Associate Director for Science

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


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**Tom Tracy, Designated Federal Officer**


February 18, 2021

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

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

## BOSC Homeland Security Subcommittee


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December 8, 2020

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## LIST OF ACRONYMS

| | |
|---|---|
| ASPECT | Airborne Spectral Photometric Environmental Collection Technology |
| AWWA | American Water Works Association |
| BG | Bacillus *globigii* |
| BOSC | U.S. EPA Board of Scientific Counselors |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CESER | U.S. EPA Center for Environmental Solutions and Emergency Response |
| CISA | Cybersecurity and Infrastructure Security Agency |
| COVID-19 | Coronavirus Disease 2019 |
| DHS | U.S. Department of Homeland Security |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ESF | Emergency Support Function |
| HS | Homeland Security |
| HSRP | Homeland Security Research Program |
| ICCOPR | Interagency Coordinating Committee for Oil Pollution Research |
| INL | Idaho National Laboratory |
| NCP | National Contingency Plan |
| NCPPS | National Contingency Plan Product Schedule |
| NSF | National Science Foundation |
| OEM | U.S. EPA Office of Emergency Management |
| OLEM | U.S. EPA Office of Land and Emergency Management |
| ORD | U.S. EPA Office of Research and Development |
| OW | U.S. EPA Office of Water |
| PFAS | Per- and polyfluorinated alkyl substances |
| RACT | Research Area Coordination Team |
| RFP | Request for proposal |
| SME | Subject Matter Expert |
| StRAP | Strategic Research Action Plan |
| TPH | Total petroleum hydrocarbons |
| WAF | Water-Accommodated-Fraction |
| WRF | Water Research Foundation |
| WSTB | Water Security Test Bed |

# INTRODUCTION

The U.S. Environmental Protection Agency's (EPA's) Homeland Security Research Program (HSRP) addresses science gaps related to remediation of environmental contamination that threatens public health and welfare, as well as science gaps related to environmental quality before, during, and after a disaster. HSRP helps EPA carry out its homeland security (HS) and emergency response mission by working closely with its partners to understand the potential threats and consequences of hazardous substance release. HSRP works in coordination with partners and stakeholders to conduct the research necessary to provide decision makers the information they need for their communities and environments to rapidly recover after a disaster.

The HSRP is focused on addressing two primary research objectives:

- Advance EPA capabilities to respond to wide-area contamination incidents; and
- Improve the ability of water utilities to prevent, prepare for, and respond to water contamination that threatens public health.

The research to address HSRP partner needs is organized into seven research areas. The research areas are descriptive of the program and align with EPA's response decisions supporting recovery under the National Response Framework, specifically with respect to EPA's lead role under Emergency Support Function #10 - Oil and Hazardous Materials Response Annex (ESF-10). EPA also leads inland responses to hazardous materials and oil releases under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Oil Pollution Act authorities. These response decisions are highly interdependent, with one decision impacting other decisions. The research areas are designed to reflect and support this interdependent system of activities through coordination across the program in support of the HSRP's two primary objectives.

The HSRP research areas are: (1) Contaminant Fate, Transport, and Exposure, (2) Contaminant Detection/Environmental Sampling and Analysis, (3) Wide-Area Decontamination, (4) Water Treatment and Infrastructure Decontamination, (5) Oil Spill Response, (6) Waste Management, and (7) Tools to Support Systems-based Decision-making.

Under the current EPA HSRP Strategic Research Action Plan (StRAP) (2019–2022), HSRP is conducting research that contributes directly to deliver research results and solutions needed to support EPA's overall mission to protect human health and the environment, fulfill the EPA's legislative mandates, and advance cross-Agency priorities.

EPA's recent reorganization, presented as the simplified Homeland Security Enterprise, positions the HSRP well to continue to assess homeland security science needs of EPA partners and stakeholders. HSRP is currently working with three primary partners to identify needs and develop products and outputs associated with their homeland security responsibilities, including protecting and restoring drinking water supplies and infrastructure, and helping communities become more resilient to natural disasters and to acts of terrorism that involve chemical, biological, or radiological weapons. EPA supports three different offices: (1) The Office of Emergency Management (OEM) which reports to the Office of Land and Emergency Management (OLEM), and provides programmatic regulations and guidance for environmental preparedness and responses; (2) The Office of Water (OW); and (3) regional offices which direct the environmental responses in the field, led by the on-scene coordinators.

The EPA Board of Scientific Counselors (BOSC) HS Subcommittee reviewed the entire program in 2019 through a review of the program's StRAP. Over the course of the next two years (2020–2021), the program

intends more in-depth reviews with the BOSC HS Subcommittee focused on research under the research areas.

The focus of this current BOSC HS Subcommittee is to review two research areas: Research Area #4 - Water Treatment Infrastructure Decontamination and Research Area #5 - Oil Spill Response.

The BOSC HS Subcommittee was given specific charge questions to guide its review. The Subcommittee reviewed the charge questions, received briefings from HSRP leadership on Research Area #4 and #5 topic areas, and met as sub-teams to address the charge questions and write this report. The BOSC HS Subcommittee meeting agenda and references to briefing materials can be found on EPA's website.

## CHARGE QUESTIONS AND CONTEXT

The HS Subcommittee was charged with addressing a series of questions about two HSRP research areas: Research Area #4 - Water Treatment Infrastructure Decontamination and Research Area #5 - Oil Spill Responses. Charge questions were as follows:

**Research Area #4 - Water Treatment Infrastructure Decontamination**

Q.1a. How well does the water research portfolio of proposed Products and Outputs respond to the partner-identified needs?

Q.1b. The Water Security Test Bed (WSTB) is a critical capability for the water research portfolio to assess full-scale decontamination approaches for contaminated infrastructure, including premise plumbing, and emergency on-site treatment of contaminated water. Are there suggested improvements to the test bed, to the planned research, and/or partner/stakeholder involvement for StRAP implementation?

Q.1c. The HSRP wastewater research is informed by Water Research Foundation (WRF) and National Science Foundation (NSF) workgroups to examine the fate of priority pathogens in wastewater collection system infrastructure and in wastewater treatment plants. To what extent is the planned research and capabilities adequate to address the acceptance and safe/effective treatment of wastewater?

**Research Area #5 - Oil Spill Response**

Q.2a. The U.S. EPA has the regulatory responsibility for maintaining the National Oil and Hazardous Substances Pollution Contingency Plan Product Schedule (NCPPS), which lists commercially available spill-treating agents for oil spill response operations. Please provide recommendation on how protocol development can be improved or advanced to support the EPA OLEM Program Office which maintains the NCPPS. How can our research program improve partner and/or stakeholder engagement beyond the EPA Program Offices?

Q.2b. Spilled oil that cannot be mechanically removed from the environment undergoes physical, chemical, and biological changes that affect the behavior and ultimate fate of the oil. To better assess oil behavior and the impact of oil on ecosystems, HSRP conducts research on biodegradation, toxicity, dispersion, and detection of oil in water. Please provide recommendations on how to

expand or improve experiments conducted within this Research Area and to improve the delivery or dissemination of products to our partners and stakeholders.

The responses of the HS Subcommittee to the charge questions are contained in the following section.

## SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Charge Question 1 Topic Area: Research Area #4 - Water Treatment Infrastructure Decontamination.

### Charge Question 1a

Q.1a. How well does the water research portfolio of proposed Products and Outputs respond to the partner-identified needs?

**Narrative**

The water research portfolio of proposed Products and Outputs responds well to the partner-identified needs. HSRP has a strong network of partners through the Office of Land Management, the Office of Water, and EPA regional offices. The HSRP has a proven track record of delivering needed products. The new EPA Center for Environmental Solutions and Emergency Response (CESER) is an asset to the HSRP program. The emphasis is on customer driven research, including the identification, planning, product development, and data transfer leads to advances in early warning, response, and recovery capabilities.

**Strengths**

- HSRP works with a wide array of partners to identify and address needs.
- HSRP has developed a number of products that directly address partner's needs.
- HSRP remains agile in adjusting to newly emerging research needs based on current events such as the Coronavirus Disease 2019 (COVID-19) and the California wildfires.
- HSRP is working with health agencies to monitor for pathogens, whether natural or terrorism related. For example, the COVID-19 experience is better positioning the Agency to develop decontamination procedures.
- HSRP has demonstrated ability to pivot from all- hazards to specific pathogens.
- HSRP is evaluating on-premise plumbing to better assess potential interior exposure. This is much needed. Homeowners are looking for guidance. Newer home construction utilizes plastic plumbing materials.
- HSRP continues to publish on various issues including but not limited to management of pathogens, lead, and Legionella.

**Suggestions**

- Develop an annual process for checking in with partners to better identify needs beyond those provided by the various EPA offices.
- Evaluate current partners and determine if there are additional partners, e.g., utilities, professional associations, etc. that should also be approached for input.
- Partner with EPA experts developing non-targeted suspect screening methods to establish a capability to expand screening and detection to additional compounds some of which might be "unknowns."

- There were two areas that the committee identified that could be strengthened. Currently cybersecurity is a medium priority area, and this should be elevated to a high priority area. While the work in sensors is going well, the research plan could be improved by developing molecular sensors to detect current and future biothreats.

## Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

**Recommendation 1a.1:** Increase the focus on cybersecurity research and prioritize consequence research and research on vulnerabilities in drinking water system security and system elements common to drinking water and wastewater systems.

***EPA Response:***

*In cooperation with EPA's Office of Water, HSRP will continue to increase its research focus into cybersecurity pertaining to drinking water and wastewater systems.*

**Recommendation 1a.2:** Leverage investments by other federal organizations and the private sector to customize sensors for priority molecules for deployment in systems critical to the water resources portfolio.

***EPA Response:***

*The HSRP agrees with the recommendation. HSRP will pursue coordination with other federal organizations and the private sector to explore options to customize sensors for priority agents in water systems.*

## Charge Question 1b

Q.1b. The Water Security Test Bed (WSTB) is a critical capability for the water research portfolio to assess full-scale decontamination approaches for contaminated infrastructure, including premise plumbing, and emergency on-site treatment of contaminated water. Are there suggested improvements to the test bed, to the planned research, and/or partner/stakeholder involvement for StRAP implementation?

**Narrative**

Ongoing development of the WSTB aims to provide full-scale, research and development test beds for water and wastewater distribution systems, large building premise plumbing, wastewater collection systems, and cybersecurity. The overall goals are to prevent, minimize, and/or ameliorate contamination events and cyberattacks. The emphasis on full-scale testing arose in part from some studies showing non-translatable pilot-scale results. For example, decontamination results for pipes contaminated with an anthrax surrogate, Bacillus *globigii* (BG), were much better at pilot scale than full scale, such that full scale required a completely different decontamination approach. Near-full-scale research is important given pilot scale research misses real world variables and increases end user acceptance (e.g., end user may not be comfortable deploying pilot scale research during a real emergency).

EPA's OW and its partnering offices have each created a list of prioritized "needs" to be addressed by HSRP research. Of 11 OW needs, five have already been addressed in some way using the WTSB. A need for cybersecurity is now being pursued. Similarly, nine of 12 partner needs have been addressed in some way. HSRP personnel believe the remaining needs can be addressed with upgrades, such as increased distribution network complexity, and installing a wastewater collection system and a small treatment system.

In addition to the above BG decontamination, other completed decontamination experiments include chlorine dioxide efficacy, physical pipe scouring and relining, Bakken crude oil flushing, washdown and per- and polyfluoroalkyl substances (PFAS) water treatment, and premise plumbing contamination and decontamination. Currently planned experiments will build on the pipe re-lining and premise decontamination, evaluate mobile emergency water treatment systems, and add radionuclide detection, decontamination, and treatment.

In August 2017, EPA's National Homeland Security Research Center convened a panel of Subject Matter Experts (SMEs) at the WSTB to elicit independent viewpoints of the overall concept, approach, implementation, and sustainability of the WSTB. Proceedings are described in EPA/600/R-18/165, "Subject Matter Expert Panel Review of the Full-Scale Water Security Test Bed (WSTB) - A Summary Report", May 2018. The SMEs represented drinking water, wastewater, and storm water trade associations; a large water and wastewater utility; state drinking water administrators; and the Idaho National Laboratory (INL). Topics discussed included distribution system, premise plumbing, and water treatment decontamination research.

A major advantage of being located at the INL is the ability to perform near full-scale radiation injections. A short half-life isotope of potassium bromide, available from academic institutions with small scale production reactors, would be an attractive surrogate tracer for simulating radiation fate and transport in the test bed. HSRP personnel are not aware of another facility that can accept and handle radioactive material and inject it into large or full-scale water piping and appurtenances. Performing experiments to detect and decontaminate radiation from water infrastructure is a big opportunity for EPA and the INL. A first test was very close to being conducted in July 2019 before it was cancelled due to a wildfire. The strategy developed by the radiation safety personnel is to store all contaminated water in frac tanks on site and let it decay naturally until radiation safety personnel verify the contamination has dropped to background levels (over approximately 30 days). The water will then be disposed of normally.

Another major opportunity is cybersecurity for the Water and Wastewater Systems Sector, which has been designated a critical infrastructure sector by the Cybersecurity and Infrastructure Security Agency (CISA). CISA is an operational component under the U.S. Department of Homeland Security (DHS). The INL has established cybersecurity test beds for wireless networks (Communications Sector) and electrical power systems (Energy Sector). Collaboration would require coordination with the DHS, which the INL is already pursuing. The impact of electromagnetic pulses on these sectors could be evaluated together as part of a full-scale exercise. Although the EPA has begun work in water and wastewater cybersecurity, they understand there is much they do not know, so they are actively looking to engage knowledgeable groups. The challenge for the EPA is engaging the DHS and private industry to build the needed physical and cybersecurity infrastructure for testing scenarios of interest.

Opportunities exist for more engagement directly with water utilities and trade associations (American Water Works Association, or AWWA, Water Environment Federation, WRF etc.). The challenge for a research organization is how to build and maintain relationships with a wide variety of stakeholders and summarize their needs with limited staff and resource. Other unaddressed needs include the following.

- Research necessary to provide input for OW training and webinar materials.

- Companies and universities are looking for partners to collaborate on industry requests for proposals (RFPs).
- Water utilities are requesting help on operator training and certification in detecting and responding to cyberattacks. The ability to host large groups of operators at the WSTB would require upgrades to office and meeting spaces, bathrooms, etc.
  Private companies are seeking full-scale technology challenges. For example, the premise plumbing test bed offers opportunities to use Cooperative Research and Development Agreements and Memorandums of Understanding to work with private industry to help design appliances such as hot water heaters, refrigerators, and dishwashers to facilitate decontamination. Previous findings indicate certain design changes would greatly facilitate decontamination. Like training and certification, the WSTB could need upgrades to accommodate private groups and potentially their large and expensive equipment.

**Strengths**

- Doing experiments at full scale can result in different results from pilot scale – example is the BG decontamination, where pilot showed no spores detected after treatment with 25-30 mg/L $ClO_2$, but data from full scale show spores persisted in presence of up to 100 mg/L $ClO_2$.
- WSTB could be easily expanded to increase the scope of research performed at the facility.
- The co-located distribution system, premise plumbing, wastewater collection, and cybersecurity test beds provide for wholistic, integrated research.
- The WSTB site has the space and some existing infrastructure needed to expand the scope of water systems research.
- Full-scale distribution system and premise plumbing experiments at the WSTB can verify pilot-scale results and provide feedback to improve pilot scale experimental processes. Different types of experiments using the distribution system and premise plumbing test beds have demonstrated efficacy.
- Premise plumbing test bed can support designing consumer appliances for decontamination.
- Unique radiation capabilities of distribution system and premise plumbing test beds.
- Location and relationships with the INL's CISA-supported cybersecurity test beds for wireless networks and electrical power systems will accelerate the EPA's cybersecurity program for water and wastewater systems and support full-scale exercises that integrate all three test beds.
- The WSTB operational technology cybersecurity program has established partners with agreements in place. It includes governmental and limited utility, industrial, university, and consulting partners.
  Increased partnering outside the EPA has broadened program opportunities, e.g., the INL cybersecurity. Partners to date have been mostly U.S. governmental, however, several prospective partners have shown interest, including utilities, industrials, universities, and consultants, which could yield new sources of funding.

**Suggestions**

The BOSC HS Subcommittee sees the panel proceedings described in the report EPA/600/R-18/165 as being comprehensive and relevant to Charge Question 1b, therefore, the Subcommittee fully supports that panel's recommendations. The following suggestions and recommendations are meant to augment the panel's recommendations.

- **On-site Test Water Formulation** – augment the above panel recommendation *Evaluate variable finished water quality impacts…* by developing capability for changing the quality of the WSTB's ground source water to create waters having different qualities, e.g., the water qualities of specific utilities.

- **Marketing** - expand awareness the WSTB's capabilities and research among potential beneficiaries of the WSTB's capabilities, such as utilities, academic researchers, research foundations, trade associations, regulators, consultants, etc., through articles in water/wastewater industry trade and scientific print media, conference presentations, webinars, etc. Note that a brief web search for the WSTB primarily turned up only official EPA material.
- **Opportunities for Collaboration -** Consider expanding collaborations to address cybersecurity for the Water and Wastewater Systems Sector, which has been designated a critical infrastructure sector by the CISA. Other potential collaborations for consideration include partnering with institutions that can provide materials (tracers) short half-life radiation injections to understand fate in these water systems.

## Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

**Recommendation 1b.1: Develop a Broad End-user Partner/Stakeholder Involvement Process** - throughout the research cycle so that products have a better chance of being used for actual emergencies and other opportunities; to include transitioning from "passive" (e.g., ad hoc encounters at professional association meetings) to more "active" stakeholder engagement that involves advanced planning, regularly scheduled encounters, and tracking networking progress. Greater emphasis should be placed on recruiting SMEs from utilities, professional association/research entities (WRF, AWWA Water Utility Council, etc.), academia, and consultants (not just EPA regions). Earlier and ongoing input should be received from a broader range of stakeholders to drive improvements in the WSTB itself and the research it generates.

***EPA Response:***

*The HSRP agrees with the recommendation for a more cohesive, streamlined process for stakeholder involvement. HSRP will explore options in collaboration with EPA's Office of Water and Idaho National Laboratory (INL) to actively receive input on the future build-out and research direction of the WSTB on a regular basis.*

**Recommendation 1b.2. Develop a Long-term WSTB Build Out Plan to Address the Full Water Treatment Cycle -** by including wastewater collection and treatment and building water systems. The current general drinking water system decontamination strategy presumes that contaminated drinking water will be discharged into wastewater collection systems. A much better understanding of contaminant "fate and transport" through wastewater systems is needed to more readily restore drinking water systems, e.g., wastewater systems will need to approve contaminated water discharges into collection systems. Conducting drinking water and wastewater research concurrently should also lead to efficiencies.

***EPA Response:***

*HSRP has a long-term WSTB plan to build-out the distribution system, adding hydraulic complexity and real-world operating conditions equivalent in size to several city blocks. The plan will also include the addition of wastewater, storm water, and reuse infrastructure. It is anticipated that this build-out plan would need several million dollars of capital investment, requiring collaboration from across the*

*government and private industry sectors. EPA's HSRP will use available resources and capabilities to continue research while simultaneously pursuing collaborative investment in building additional capabilities addressed in the WSTB build-out plan.*

## Charge Question 1c

Q.1c. The HSRP wastewater research is informed by Water Research Foundation (WRF) and National Science Foundation (NSF) workgroups to examine the fate of priority pathogens in wastewater collection system infrastructure and in wastewater treatment plants. To what extent is the planned research and capabilities adequate to address the acceptance and safe/effective treatment of wastewater?

**Narrative**

After the 2014 Ebola outbreak, there was a high level of national interest in the fate of pathogens in water resource recovery facilities (WRRFs). HSRP has actively worked to address many of the questions associated with the potential survivability of these priority pathogens within the wastewater collection system and wastewater treatment plants, including their potential to be released back into the environment.

**Strengths**

- HSRP is actively working with partners to examine the fate of priority pathogens within wastewater.
- The Training and Education facility in Cincinnati, Ohio offers a valuable resource to model many different scenarios at pilot scale.

**Suggestions**

- Reach out to groups, such as MITRE Corporation and others, that are currently working on COVID-19-related wastewater surveillance programs to be actively involved in the evolving efforts.
- Develop a disaster/emergency response capability that would enable HSRP researchers to respond shortly after an disaster/emergency to conduct research on the impact of the disaster on the local wastewater treatment infrastructure, as well as conduct research on the impact of compromise/failures due to the disaster of the wastewater treatment infrastructure on both human health and the environment.
- HSRP should explore the potential impacts of priority pathogens on frontline workers in the wastewater industry.

## Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

**Recommendation 1c.1:** To improve the adequacy and translational value of the research portfolio, HSRP should improve the connection between pilot scale studies and field studies by partnering with municipalities researching priority pathogens in full scale operating wastewater systems.

***EPA Response:***

*HSRP will explore various options to connect pilot- and field-scale research.*

**Recommendation 1c.2:** HSRP should increase research into the nature and extent of storm water related releases of priority pathogens in untreated sewage from treatment plants in natural disastersto address a limitation of the existing research portfolio.

***EPA Response:***

*The HSRP will continue to incorporate research on storm water-related homeland security high priority agent releases. This area of research offers a nexus of work between HSRP's established work on wastewater and emerging storm water research as part of the wide area remediation research portfolio, and with ORD's Safe and Sustainable Water Resources (SSWR) national research program's efforts on storm water management.*

Charge Question 2 Topic Area: Research Area #5 - Oil Spill Response

## Charge Question 2a

Q.2a. The U.S. EPA has the regulatory responsibility for maintaining the National Oil and Hazardous Substances Pollution Contingency Plan Product Schedule (NCPPS), which lists commercially available spill-treating agents for oil spill response operations. Please provide recommendation on how protocol development can be improved or advanced to support the EPA OLEM Program Office which maintains the NCPPS. How can our research program improve partner and/or stakeholder engagement beyond the EPA Program Offices?

**Narrative**

The EPA Office of Research and Development (ORD) recognizes the importance of providing strategic partners reliable resources that support effective and safe responses to petrochemical releases. Understanding the impact of approved chemicals on local and regional ecosystems, and developing standard testing and evaluation protocols are priorities for ORD. To accomplish this mission, as set forth in Subpart J, Section 311 of the *Clean Water Act*, ORD has worked with partners to prioritize needs and

undertaken significant efforts to standardize these test and evaluation protocols for oil spill response. Recent initiatives have included protocol development in the product areas of dispersants, surface washing agents, and herding agents used for in-situ burning.

ORD recognizes that studying the behavior and environmental fate of oil spill response agents and their degradation products is necessary to assure guidance for safe use, based upon a full understanding of ecological impacts. In the past five years, significant efforts have been undertaken to characterize biodegradation and photo-weathering of oils. Studies have specifically examined photo-weathering influences in hypersaline waters, wave-based mechanical dispersion of oil plumes, and oil droplet, density, and dispersion modelling.

HSRP identified the need to update and standardize protocols, last updated in 1994. On January 22, 2015, EPA released proposed rule changes (*Federal Register* Volume 80, No. 14) to accomplish this update. Several changes to the National Contingency Plan (NCP) were made, including changing the Water-Accommodated-Fraction (WAF) methodology from use of a blender to a slow-stir process. In addition to the proposed changes to the WAF test protocol, ORD wanted to include new species and taxonomies to broaden its understanding of oil and agent toxicology; however, these changes were not incorporated into the 2015 final rule. Broadening the species and taxa of test subjects provides increased understanding of the chemical impact to the varied biological systems in which they are deployed.

Efforts by HSRP to increase the number of species for toxicology testing are well directed. Specifically, prioritization of species selection based on historical use of standard test species, strong existing protocols, and large databases provides a benchmarking capability which leverage past investments, existing expertise, and data. Inclusion of freshwater species, which supports data gathering to evaluate oil spill response agents in freshwater is an important goal. Expansion to include invertebrates is well justified by the need to broaden the depth of ecosystem element representation.

Recently, ORD identified a need to evaluate the effectiveness of surface washing agents. Cleaning shoreline and riparian zones using surface washing agents is time consuming and requires extensive resources. Research staff recently developed a protocol for evaluating agent effectiveness. The initial methodology was not consistently repeatable by end users, perhaps due to chemical variability between agents. To address these limitations staff have suggested methodological changes to increase protocol reliability.

Recent HSRP projects have aimed to characterize oil slick thickness and spread using emerging technological instruments, such as unmanned aerial vehicles, the EPA Airborne Spectral Photometric Environmental Collection Technology (ASPECT) aircraft and orbital satellites. Oil slicks are dynamic, and it is crucial to fully characterize plumes to provide responders information for accurate and timely remedial strategy development. While initial results of this research are promising, future project milestones include consolidating layered of datasets, which should improve the understanding of slicks and to fully develop three-dimensional models. Data gathered from this project may also prove valuable for testing agent effectiveness.

An ongoing identified need includes building and maintaining a stockpile of reference oils with which to conduct product testing. While ORD has reached out to numerous sources, it has encountered obstacles to procure small samples (a few barrels) of the identified oils. The oil needed for this testing is limited to specific sourced locations and grades and cannot include general stockpile blends. Vendors who maintain supplies of these oils have been unwilling to sell small quantities to ORD. Recent disasters have further depleted limited supplies of oils, so the need to identify and maintain a reliable source is great. The reference oils requirement cannot be overstated, given the dramatic increase in domestically produced

shale oils, which are comprised of shorter carbon chains, and contain little or no sulfur. Past research conducted on imported heavier crude oils do not yield the same results as new domestic crude oil as far as droplet size, density, and ability to float or sink during aquatic spills or leaks. Additionally, with imported crude oils, common environments for spills—oceans and ports—are far different than those for domestically produced oils. Domestic crude production expands spill potential locations to include inland lakes and rivers, which require distinctly different testing and species for toxicology research. Domestic crude oils that lend themselves to faster bioremediation and natural attenuation in the soils are much easier to refine with lower energy expended to yield final products and therefore have a smaller carbon footprint that heavier, more sulfur laded imported crude oils.

Sandia National Laboratory, in conjunction with the U.S. Department of Energy (DOE) has in recent years acquired quantities of domestically produced crude oil for testing related to transportation safety. These entities might well provide a new pathway for access to quantities of domestically produced crude oils for the continued ORD research into crude oil spill cleanup and remediation.

HSRP has demonstrated extensive use of leveraging partnerships to supplement existing funds and overcome resource limitations. Leveraging partners continues to be a critical force multiplier for HSRP. Collaborations with the National Academy of Sciences, Pegasus Technical Services, Interagency Coordinating Committee on Oil Pollution Research (ICCOPR), Gulf Coast Research Initiative, and the Woods Hole Oceanographic Institute, have produced critical information and understanding of the chemical fate and ecological impact of oil spill response agents. Emergency response support teams continue to foster strong relationships with the National Response Teams and ICCOPR to identify gaps in research and prioritize research needs. A recent study, initiated in response to a stated need of OLEM, examined oil density, droplet size distribution, and their impact on listed dispersion product effectiveness. These partnerships resolve gaps in knowledge and expertise, overcome limitations of test facilities, and add critical research personnel to the larger team.

**Strengths**

- Given resource limitations, ORD has demonstrated consistent ability to leverage partner and stakeholder collaboration to broaden its knowledgebase, testing capability, and output to meet their mission.
- ORD consistently test products on a few standard species, as defined in Appendix C of the *Clean Water Act,* using Species Sensitivity Distribution estimate toxicity in untested but potentially impacted species in an ecosystem concern.
- Prioritization of species selection based on historical use of standard test species, strong existing protocols, and large databases that can be leveraged for benchmarking is a valuable strategy because it leverages past investments, existing expertise, and data. The inclusion of freshwater species and algae to generate data to support evaluation oil spill response agents in freshwater and across broader taxa is an important goal. Expansion to invertebrates is well justified by the need to expand the depth of ecosystem element representation.
- The research into oil slick characterization and utilization of advanced technologies is impressive. Although the stakeholder need for this research was response-based, data will provide information for development of methodology and test protocols for oils and agents in the future.

**Suggestions**

- HSRP could broaden their strategic partnerships through engagement with the European spill response organizations and other international organizations to potentially include the

- Commonwealth Scientific and Industrial Research Organization, as well as the Canadian Government through the multi-partner research initiative.
- HSRP could consider the developing protocols for testing the toxicity and effectiveness of sorbents. Sorbents are used occasionally but have yet to be identified as a priority for testing by stakeholders.
- ORD should consider developing a clear justification for raising the priority of research that assesses the toxicity/phototoxicity of chemicals and their long-term degradation and metabolic products to ensure that the research is added to a future rule making docket. Examining the toxicological effects of chemicals can be challenging. A more effective justification may balance the view that such research, though building on considerable strengths of ORD, is not urgent.

## Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

**Recommendation 2a.1:** Establish a working group to identify and eliminate institutional barriers so procurement of reference oils used for product testing, including small samples of specific grades and source locations is simple and reliable over time. This might include legal, purchasing, scientists, in both EPA and source organizations, as well as connecting with other government agencies such as DOE and the National Laboratory System.

***EPA Response:***

*ORD is monitoring the status of H.R. 6395 William M. Thornberry National Defense Authorization Act (NDAA) for Fiscal Year 2021, which if passed may address some of the barriers discussed during the BOSC meeting and possibly allow EPA to serve as a 'clearing house' for oils so that other agencies can get access to them.*

## Charge Question 2b

> Q.2b. Spilled oil that cannot be mechanically removed from the environment undergoes physical, chemical, and biological changes that affect the behavior and ultimate fate of the oil. To better assess oil behavior and the impact of oil on ecosystems, HSRP conducts research on biodegradation, toxicity, dispersion, and detection of oil in water. Please provide recommendations on how to expand or improve experiments conducted within this Research Area and to improve the delivery or dissemination of products to our partners and stakeholders.

**Narrative**

ORD maintains a Research Area Coordination Team (RACT) with a focus on oil spills. They work with multiple collaborators and partners (including Canada, U.S. Coast Guard, National Oceanic and Atmospheric Administration, U.S. Department of Interior, etc.). The research is supported by an Oil Spill Liability Trust Fund. The RACT's primary activities include developing approaches for efficient and effective management of oil releases, establishing protocols for regulations and spill response efforts, and providing scientific support to program and regional offices, and federal partners. The current research and operations focus on methods to manage oil marine spills (e.g., in situ burning, dispersing agents, surface washing, solidifiers, and herders). Much of their work is dependent on reference oils to fully characterize oils for the NCPPS, to conduct research on a wide variety of oils in the laboratory, test tank (OHMSETT), and field, and to conduct toxicity, biodegradability, and dispersive behavior tests on spilled

oil. These three needs require sample sizes ranging from 500 ml to multiple barrels.[1]

**Strengths**

- Publication of results in high impact journals,
- Presentations at prominent conferences,
- Focus on expanding the global knowledge base, service as SMEs,
- International recognition of the oils research program,
- The move to improve autonomous and remotely operate samplers (air, water, sediments, and oils), monitoring platforms, and sensors,
- Innovation and creativity to solve difficult problems, such as the recent correlation between fluorescence and total petroleum hydrocarbons (TPH) which will enable more rapid and accurate estimates of plume size and amount spilled,
- Outstanding interagency collaborations (e.g., leveraging resources, expertise exchange, and sharing of data), and
- Actively incorporating lessons learned from Deepwater Horizon.

**Suggestions**

- Expand focus of biodegradation tests to include anaerobic conditions which might be expected at depth and in sediments.
- Since COVID-19, the U.S. Government purchased domestically produced shale oils from North Dakota (Bakken) and Texas (Permian) that are lighter oils with lower sulfur than the Middle Eastern crudes that traditionally populated the strategic petroleum reserve. EPA is still having difficulty purchasing domestic light sweet oil. We understand there are challenges in accessing the strategic reserve because the oils are blended and permission from the president is required to acquire samples, therefore it is suggested that EPA consider ways to cost-effectively purchase smaller amounts through a third party vendor, for example on the barrel scale.

## Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

**Recommendation 2b.1:** Establish a task force with members from private entities, stakeholders, and government organizations to identify and eliminate barriers to the timely acquisition of small amountsof oils, fuels, and related materials at reasonable cost for research purposes.

***EPA Response:***

*The Interagency Coordinating Committee on Oil Pollution Research (ICCOPR), led by the United States Coast Guard, is for federal agencies only, as mandated by the Oil Pollution Act. A variety of the recommended discussions would not be suitable with private entities in such a "task force" setting. ORD will explore other options for access to oils with private entity stakeholders, notably in the context of external outreach engagements as indicated in our Response to 2a.1 above.*

[1] Work with Coast Guard on potentially receiving oil from ongoing responses.

**Recommendation 2b.2:** Strengthen connectivity between EPA researchers and product users in field applications to ensure the knowledge attainable from field use of products reaches EPA, informs research needs, and drives translational science elements of EPA's research program. Toward this end, develop and socialize (at meetings like the Hot Zone Conference) a protocol for direct engagement with partner product users at time of use.

***EPA Response:***

*EPA currently participates in the International Oil Spill Conference, Clean Gulf and Clean Pacific Conferences, and the National Response Team and Regional Response Team (NRT and RRT) Co-Chair meetings. Each of these is attended by emergency responders, product manufacturers, oil industry practitioners, and researchers. HSRP oil response research staff do not currently attend the Hot Zone Conference, but we will consider this as a viable mechanism to further our engagement and strengthen connectivity.*

**Recommendation 2b.3:** Identify and address priority gaps in research and products (e.g. surface burn, surface wash, dispersants, herders, sorbents) for effective handling of spills to inland freshwaters.

***EPA Response:***

*Currently HSRP has included freshwater treatments in dispersion experiments, in the development of the surface washing agent protocol, and in our aerobic biodegradation experiments with Alaskan oil. As HSRP moves forward, we intend to expand research over the salt continuum, in consultation with partners.*

# SUMMARY LIST OF RECOMMENDATIONS

## Charge Question 1a: How well does the water research portfolio of proposed Products and Outputs respond to the partner-identified needs?

- **Recommendation 1a.1:** Increase the focus on cybersecurity research and prioritize consequence research and research on vulnerabilities in drinking water system security and system elements common to drinking water and wastewater systems.
- **Recommendation 1a.2:** Leverage investments by other federal organizations and the private sector to customize sensors for priority molecules for deployment in systems critical to the water resources portfolio.

## Charge Question 1b: The Water Security Test Bed (WSTB) is a critical capability for the water research portfolio to assess full-scale decontamination approaches for contaminated infrastructure, including premise plumbing, and emergency on-site treatment of contaminated water. Are there suggested improvements to the test bed, to the planned research, and/or partner/stakeholder involvement for StRAP implementation?

- **Recommendation 1b.1: Develop a Broad End-user Partner/Stakeholder Involvement Process** - throughout the research cycle so that products have a better chance of being used for actual emergencies and other opportunities; to include transitioning from "passive" (e.g., ad hoc encounters at professional association meetings) to more "active" stakeholder engagement that involves advanced planning, regularly scheduled encounters, and tracking networking progress. Greater emphasis should be placed on recruiting SMEs from utilities, professional association/research entities (WRF, AWWA Water Utility Council, etc.), academia, and consultants (not just EPA regions). Earlier and ongoing input should be received from a broader range of stakeholders to drive improvements in the WSTB itself and the research it generates.
- **Recommendation 1b.2. Develop a Long-term WSTB Build Out Plan to Address the Full Water Treatment Cycle -** by including wastewater collection and treatment and building water systems. The current general drinking water system decontamination strategy presumes that contaminated drinking water will be discharged into wastewater collection systems. A much better understanding of contaminant "fate and transport" through wastewater systems is needed to more readily restore drinking water systems, e.g., wastewater systems will need to approve contaminated water discharges into collection systems. Conducting drinking water and wastewater research concurrently should also lead to efficiencies.

## Charge Question 1c: The HSRP wastewater research is informed by Water Research Foundation (WRF) and National Science Foundation (NSF) workgroups to examine the fate of priority pathogens in wastewater collection system infrastructure and in wastewater treatment plants. To what extent is the planned research and capabilities adequate to address the acceptance and safe/effective treatment of wastewater?

- **Recommendation 1c.1:** To improve the adequacy and translational value of the research portfolio, HSRP should improve the connection between pilot scale studies and field studies by partnering with municipalities researching priority pathogens in full scale operating wastewater systems.
- **Recommendation 1c.2:** HSRP should increase research into the nature and extent of storm water related releases of priority pathogens in untreated sewage from treatment plants in natural disasters to address a limitation of the existing research portfolio.

Charge Question 2a: The U.S. EPA has the regulatory responsibility for maintaining the National Oil and Hazardous Substances Pollution Contingency Plan Product Schedule (NCPPS), which lists commercially available spill-treating agents for oil spill response operations. Please provide recommendation on how protocol development can be improved or advanced to support the EPA OLEM Program Office which maintains the NCPPS. How can our research program improve partner and/or stakeholder engagement beyond the EPA Program Offices?

- **Recommendation 2a.1:** Establish a working group to identify and eliminate institutional barriers so procurement of reference oils used for product testing, including small samples of specific grades and source locations is simple and reliable over time. This might include legal, purchasing, scientists, in both EPA and source organizations, as well as connecting with other government agencies such as DOE and the National Laboratory System.

Charge Question 2b: Spilled oil that cannot be mechanically removed from the environment undergoes physical, chemical, and biological changes that affect the behavior and ultimate fate of the oil. To better assess oil behavior and the impact of oil on ecosystems, HSRP conducts research on biodegradation, toxicity, dispersion, and detection of oil in water. Please provide recommendations on how to expand or improve experiments conducted within this Research Area and to improve the delivery or dissemination of products to our partners and stakeholders.

- **Recommendation 2b.1:** Establish a task force with members from private entities, stakeholders, and government organizations to identify and eliminate barriers to the timely acquisition of small amounts of oils, fuels, and related materials at reasonable cost for research purposes.
- **Recommendation 2b.2** Strengthen connectivity between EPA researchers and product users in field applications to ensure the knowledge attainable from field use of products reaches EPA, informs research needs, and drives translational science elements of EPA's research program. Toward this end, develop and socialize (at meetings like the Hot Zone Conference) a protocol for direct engagement with partner product users at time of use.
- **Recommendation 2b.3:** Identify and address priority gaps in research and products (e.g. surface burn, surface wash, dispersants, herders, sorbents) for effective handling of spills to inland freshwaters.

# APPENDIX A: MEETING AGENDA

**Day 1: Thursday August 20, 2020, Eastern Daylight Time**

| | | |
|---|---|---|
| 12:00 - 12:10 | Introduction and FACA rules<br><br>Welcome and Opening Remarks<br>Introduction of BOSC HS Subcommittee Members | Tom Tracy, Designated Federal Officer (DFO)<br>Paula Olsiewski, BOSC Homeland Security (HS) Subcommittee Chair |
| 12:10 - 12:15 | ORD Welcome | Bruce Rodan, PhD<br>ORD Associate Director for Science |
| 12:15 - 12:35 | CESER Welcome<br>Center-NPD structure<br>ORD COVID-19 research | Greg Sayles, Director<br>Center for Environmental Solutions and Emergency Response (CESER) |
| 12:35 - 13:00 | Homeland Security<br>Research Program Overview | Shawn Ryan, HS<br>National Program Director<br>Sang Don Lee, HS Principal Assoc. |
| 13:00 - 13:15 | Break (15 min) | |
| 13:15 - 14:00 | Overview of Oil Spill Response Research | Robyn Conmy, CESER |
| 14:00 - 15:45 | NCPPS Protocol Development (30 min) | |
| | • NCP Reference Oil Selection | Robyn Conmy, CESER |
| | • Treating Agent Toxicity Test | Mace Barron, CESER |
| | • Surface Washing Agent Efficacy Protocol | Robyn Conmy, CESER |
| | Break (10 min) | |
| | Behavior, Fate, and Effects (40 min) | |
| | • Oil Biodegradation | Kiara Lech, CESER |
| | • Toxicity of Oil and Agents | Mace Barron, CESER |
| | • In situ Burning Air Emissions | Brian Gullett, Center for Environmental Measurement and Modeling (CEMM) |
| | • Oil Dispersion at Lab and Tank Scales | Robyn Conmy, CESER |
| | Spilled Oil Detection Tools (25min) | |
| | • Detection of Deepwater Plumes | Alex Hall, CESER |
| | • Oil Slick Detection | Blake Schaeffer, CEMM |
| | • AUV and ROV Platform Development | Robyn Conmy, CESER |
| 15:45 - 15:50 | Public Comment | Tom Tracy, DFO |
| 15:50 - 16:00 | Break (10 min) | |
| 16:00 - 17:00 | Subcommittee Worktime | |

**Day Two – Friday, August 21, 2020, Eastern Daylight Time**

| | | |
|---|---|---|
| 12:00 - 12:30 | Overview of Water Research | Jeff Szabo, CESER |
| 12:30 - 14:30 | Full scale research at the WSTB (25 min)<br>• Decontamination methodologies (distribution system and premise plumbing)<br>• Sensors and automatic flushing<br>• Cybersecurity<br>• WSTB Videos and Virtual Tours | Jeff Szabo, CESER<br>John Hall, CESER<br>Jim Goodrich, CESER |
| | Premise plumbing research (10 min) | Helen Buse, CESER<br>Matthew Magnuson, CESER |
| | Break (10 min) | |
| | Wash-water treatment methodologies (15 min) | Matthew Magnuson, CESER<br>Jim Goodrich, CESER |
| | Wastewater research (10 min) | Matthew Magnuson, CESER |
| | Sensor research (10 min) | John Hall and Jeff Szabo, CESER |
| | Source water and storm water research (20 min)<br>• Rainfall simulator, field sampling and field installation videos | Anne Mikelonis, CESER<br>Jim Goodrich, CESER<br>Katherine Ratliff, CESER |
| | Water system modeling tools (15 min) | Terra Haxton, CESER<br>Katherine Ratliff, CESER |
| | Water sampling strategies, collection, and analysis methods (5 min) | Sarah Taft, CESER |
| 14:30 - 14:45 | Break (15 min) | |
| 14:45 - 16:00 | Subcommittee Worktime | |
| 16:00 - 17:00 | Q&A | Shawn Ryan, Sang Don Lee, Jeff Szabo, Robyn Conmy |

# APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

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

- Agenda
- Charge questions
- HS Draft StRAP FY 2019–2022

***Informational Materials***

- Virtual Participation Guide
- Presentation: Introduction to the Homeland Security Research Program
- Presentation: EPA Office of Research and Development Homeland Security Research Overview
- Presentation: U.S. EPA's Office of Research and Development Overview

BOSC
BOARD OF SCIENTIFIC COUNSELORS

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

## BOSC Safe and Sustainable Water Resources Subcommittee

| | | |
|---|---|---|
| Joseph Rodricks, Ph.D., DABT (Chair)<br>*Ramboll Environ* | Steve Carr, Ph.D.<br>*Los Angeles County Sanitation District* | Fred Hitzhusen, Ph.D.<br>*Ohio State University* |
| Robert Blanz, Ph.D., PE (Vice Chair)<br>*Arkansas Department of Energy and Environment* | Shahid Chaudhry, M.Sc.<br>*California Energy Commission* | Lucinda Johnson, Ph.D.<br>*University of Minnesota* |
| Scott Ahlstrom, PE, PMP<br>*Corix Utilities* | David Cole, M.S.<br>*Oregon Department of Environmental Quality* | Kate Lajtha, Ph.D.<br>*Oregon State University* |
| Jared Bales, Ph.D., M.S.<br>*Consortium of Universities for the Advancement of Hydrologic Science* | Timothy Davis, Ph.D.<br>*Bowling Green State University* | Michelle Lorah, Ph.D.<br>*U.S. Geological Survey* |
| Beth Boyer, Ph.D., M.S.<br>*Penn State University* | Tim Verslycke, Ph.D.<br>*Gradient* | John Lowenthal, M.S., PWS, PWD<br>*Cardno* |
| Stephen Weisberg, Ph.D.<br>*Southern California Coastal Water Research Project Authority* | Joel Ducoste, Ph.D., BCEEM<br>*North Carolina State University* | Elizabeth Fassman-Beck, Ph.D., M.Sc.<br>*Southern California Coastal Water Research Project* |
| | John White, Ph.D.<br>*Louisiana State University* | |

## EPA Contact

**Tom Tracy, Designated Federal Officer**

January 15, 2021

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

# CONTENTS

## LIST OF ACRONYMS

| | |
|---|---|
| BOSC | U.S. EPA Board of Scientific Counselors |
| CATME | Combustion Alternative Treatment for Microplastics in the Environment |
| COVID-19 | Coronavirus Disease 2019 |
| EPA | U.S. Environmental Protection Agency |
| FY | Fiscal Year |
| LIDAR | Light Detection and Ranging |
| NHD | National Hydrography Dataset |
| NOAA | National Oceanic and Atmospheric Administration |
| NWI | National Wetland Inventory |
| ORD | U.S. EPA Office of Research and Development |
| OW | U.S. EPA Office of Water |
| RARE | Regional Applied Research Efforts |
| SSWR | Safe and Sustainable Water Resources national research program |
| StRAP | Strategic Research Action Plan |
| USACE | United States Army Corps of Engineers |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |

## INTRODUCTION

The U.S. Environmental Protection Agency (EPA's) Board of Scientific Counselors (BOSC) Safe and Sustainable Water Resources (SSWR) Subcommittee appreciates the opportunity to provide input on planned research products. The Subcommittee met October 28–29, 2020, November 17, 2020, and December 2, 2020 to review the initial progress on implementation of the fiscal years (FY) 2019–-2022 SSWR Strategic Research Action Plan (StRAP). The Subcommittee understands that the products are at an early stage and recognizes the need for time and flexibility to carry out research during the Coronavirus Disease 2019 (COVID-19) pandemic. The Subcommittee appreciates the creative efforts to continue working to the extent possible from remote locations.

## CHARGE QUESTIONS AND CONTEXT

The SSWR Subcommittee was charged with addressing a series of questions about the SSWR Research Program. Charge questions were as follows:

> Q.1: Progress towards characterizing microplastics in the environment and uncertainties about their potential environmental health effects requires reliable and consistent methods. SSWR is conducting research to develop and standardize collection, extraction, identification and quantification methods for microplastics. Based on the progress and results to date, what suggestion(s) or recommendation(s) does the Subcommittee offer on research into addressing the uncertainties and challenges associated with the Agency's efforts to develop reliable and consistent microplastics analytical methods? [Research Area 1, Output 4]
>
> Q.2: Existing geospatial datasets are often limited with respect to mapping rivers, streams, and wetlands with the degree of accuracy and at the resolution needed to support federal, state, tribal, and local water management decisions, including identifying "waters of the United States" subject to Clean Water Act jurisdiction. SSWR is leveraging existing interagency partnerships to improve the accuracy and application of geospatial data for mapping aquatic resources nationally. What suggestion(s) or recommendation(s) does the Subcommittee offer on further identifying emerging technologies, methodologies, and datasets to improve aquatic resource mapping tools and their application for federal, state and local water management decisions? [Research Area 2, Output 1]
>
> Q.3: To help reduce health risks associated with exposure to fecal contaminants in recreational waters, SSWR is conducting research to strengthen the scientific basis of existing, and to advance new, fecal contaminant detection methods, source tracking, predictive tools, and health effects assessments that contribute to human health recreational water quality criteria programs. As the research progresses, what suggestion(s) or recommendation(s) does the Subcommittee offer on continuing to identify and conduct research of greatest importance to advancing human health protection from fecal contaminants in recreational waters? [Research Area 3, Output 1]

The responses of the SSWR Subcommittee to the charge questions are contained in the following section.

# SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

## Charge Question 1

> Q.1: Progress towards characterizing microplastics in the environment and uncertainties about their potential environmental health effects requires reliable and consistent methods. SSWR is conducting research to develop and standardize collection, extraction, identification and quantification methods for microplastics. Based on the progress and results to date, what suggestion(s) or recommendation(s) does the Subcommittee offer on research into addressing the uncertainties and challenges associated with the Agency's efforts to develop reliable and consistent microplastics analytical methods? [Research Area 1, Output 4]

**Narrative**

Numerous recent studies have documented the pervasiveness of microplastics, which EPA's Office of Research and Development (ORD) defines as particles 5mm–1 nm[1], in the environment that may lead to human exposure through inhalation and ingestion. Researchers throughout the world are working to build a foundational understanding of the sources, transport routes, overall fate, and health impacts of microplastics. Science professionals worldwide commend SSWR for entering this field, but EPA is late to start researching and their investments must be selective to ensure they complement, rather than duplicate, the research that other institutions are already undertaking. The research SSWR is conducting achieves that goal.

SSWR's initial strategy focuses on measurements, which the Subcommittee believes is well-advised. Current limitations in method harmonization, and quality assurance of those methods, will prevent or hinder progress in understanding the effects of microplastics in the environment.

While there are several international efforts to achieve microplastic method standardization, SSWR has appropriately identified three niches that are relatively understudied, and for which they can effectively address gaps in the field. The first of those is measurement methods for microplastics in sediments. Most ongoing work is focused on measurements in aqueous media. Sediments present a challenge because of the additional step needed to separate plastics from the sediment before researchers can perform the measurements. This is a particularly appropriate activity for SSWR because EPA runs the National Coastal Condition Assessment, a national program that assesses that ecological condition of coastal aquatic resources, including sediments. This provides a natural implementation outlet for this product.

The second methodological research area is nanoplastics, which is another wise choice. Unlike microplastic measurements, which have many investigators, there are few groups working on nanoplastics measurement methods, despite increasing research that point to the toxicological nature of these smaller particles. ORD is scientifically well-positioned to implement this research, given their history in assessing non-plastic nanotechnology.

The third research area is exploring cheaper methods that can serve as a prescreening tool to determine whether or not implementing more expensive methods yielding information on shape and chemical composition is warranted. In particular, their proposal to investigate the combustion alternative treatment for microplastics in the environment (CATME) method for rapid determination of total plastics in sediments shows great promise. Such prescreening techniques, if successful, will have many applications. For instance, more frequent, cost-effective screening of drinking water would help

management groups focus and prioritize geographies or water sources that need additional treatment. Simplified methods would also allow volunteer groups to contribute to the knowledge base. This is another part of the measurement field that is relatively understudied, and to which SSWR could make a substantial contribution.

Measurement methods to characterize microplastics is the appropriate starting point. SSWR should begin work now towards developing a strategy for incorporating both environmental and human health effects into the next StRAP. Health and toxicological effects can vary by particle size, shape, and composition, as well as potential pathways of exposure. Consequently, developing a research framework on those micro or nanoplastics that have the greatest potential for adverse environmental and health outcomes is critical in tandem with methodological development.

**Strengths**

SSWR has identified measurement method niches which are understudied and for which they have competencies that make them the right group to pursue those research lines.

BOSC commends SSWR for forming partnerships to achieve this mission. In particular, their work through the Regional Applied Research Effort (RARE), a program that responds to the high-priority research needs of EPA regional offices, has helped connect them with the State of California, which is scheduled to become the first state to begin requiring routine monitoring of microplastics. Moreover, their partnership with the American Society for Testing and Materials facilitates collaboration with other researchers who are working to standardize measurement methods.

**Suggestions**

Continue investment in the three measurement niches as proposed. These are well-thought out and will make valuable contributions to the field. SSWR's capacity-building investments to focus on producing quality assurance and laboratory accreditation guidelines impressed the Subcommittee.

## Recommendations

The Subcommittee offers the following recommendation to support the relevant Agency priorities:

**Recommendation 1.1:** Measurement methods to characterize microplastics is the appropriate starting point. SSWR should begin work now towards developing a strategy for incorporating both environmental and human health effects into the next StRAP.

***EPA Response:***

*SSWR agrees with this recommendation and the Subcommittee's recognition of the need for ORD/SSWR to identify research niches that are understudied, and for which ORD/SSWR has the appropriate capabilities to pursue. We are presently working with our partners to understand their FY23-26 microplastic research priorities and will accordingly align ORD/SSWR's available resources to support these needs. Additionally, the SSWR National Research Program Director (NPD) and Watersheds Associate NPD and the Output Lead and other Center researchers are participating in national/international virtual meetings (e.g., Society of Environmental Toxicology and Chemistry (SETAC) microplastics webinar series, Southern California Coastal Water Research Program (SCCWRP) microplastics and human health webinar series, National Nano Initiative (NNI)*

*nanoplastics meetings) and reviewing peer-reviewed publications to help identify areas of future microplastic research to which ORD can make the most impactful contributions.*

## Charge Question 2

Q.2: Existing geospatial datasets are often limited with respect to mapping rivers, streams, and wetlands with the degree of accuracy and at the resolution needed to support federal, state, tribal, and local water management decisions, including identifying "waters of the United States" subject to Clean Water Act jurisdiction. SSWR is leveraging existing interagency partnerships to improve the accuracy and application of geospatial data for mapping aquatic resources nationally. What suggestion(s) or recommendation(s) does the Subcommittee offer on further identifying emerging technologies, methodologies, and datasets to improve aquatic resource mapping tools and their application for federal, state and local water management decisions? [Research Area 2, Output 1]

**Narrative**

SSWR is responding to the needs of EPA's Office of Water (OW) and the Army Corps of Engineers (USACE) to identify the jurisdictional Waters of the United States, particularly with respect to the challenges associated with identifying headwater streams (ephemeral and intermittent) and adjacent wetlands connected to jurisdictional rivers under "normal" flow (i.e., a typical year as defined in the Navigable Waters Protection Rule). The Agency is participating in an interagency collaboration with other partners, including USACE, the United States Geological Survey (USGS), and the United States Fish and Wildlife Service (USFWS) to discuss the uses, strengths and limitations of existing data such as the National Hydrography Datasets (NHD) and National Wetland Inventory (NWI) and to recommend possible improvements to those data sets. The goal of SSWR's research effort is to improve upon the classification of jurisdictional waters in areas that cannot be mapped accurately using existing data sources. This effort focuses on use of high-resolution imagery, topographic data, and various types of models distributed across multiple geographic areas that represent a particular challenge for mapping using existing tools. SSWR's effort is concentrated on case study watersheds with existing high-resolution data and modeling tools, with the expectation that tools, and approaches developed for these areas can be extrapolated to other regions.

**Strengths**

The Agency is to be commended for its participation in interagency efforts (e.g., with USACE, USFWS, and USGS) to identify strategies and tools for mapping jurisdictional waters, especially with a focus on filling gaps, and addressing known deficiencies in regional data sources such as NWI and NHD. In addition, the Agency has conducted a comprehensive literature review and data assessment to identify specific areas for which there is extensive high-resolution data (including satellite imagery, light detection and ranging [LIDAR]) as well as modeling tools (e.g., dynamic TOPMODEL). The group has identified a specific gap in modeling approaches that can be used to predict the probability of riverine flooding that will lead to overflow into adjacent wetlands.

**Suggestions**

The Agency is participating in interagency discussions regarding the use and enhancement of regional data sets that could prove useful in mapping a large percentage of the jurisdictional waters. SSWR's research

effort seeks to fill the gap in areas that cannot be mapped using those existing data and tools. Additional resources that might be explored include use of the models WetLandscape or PHyLiSS (McKenna et al. 2018), which was developed in the Prairie Pothole Region to predict wetland water levels. For mapping adjacent wetlands under specific flow regimes, enhanced NWI (attributed with hydrogeomorphic characteristics) might be useful. In addition, the Restorable Wetland Index maps based on topographic and land cover characteristics (https://data.nrri.umn.edu/data/dataset/minnesota-restorable-wetland-index) may be another useful starting point for refining wetland connectivity maps.

The SSWR effort is currently addressing three difficult landscape settings where existing mapping tools are problematic. These efforts could be further focused and prioritized through more sustained participation of USACE practitioners to help define the most urgent mapping issues (i.e., utilizing a co-production model of research engagement).

Narrowly defined, Charge Question 2 focuses on emerging technologies, methods and data sets that mightbe used to refine estimates of locations of ephemeral and intermittent stream channels and to identify potentially connected wetlands adjacent to jurisdictional rivers and streams. Each of these represent distinct mapping challenges because they represent a gradient of conditions that are defined by the physical structure of the landscape, a dynamic hydrologic regime, and antecedent moisture conditions, creating difficulties in deriving a strict classification. Rather, the gradient of conditions that lead to channel formation and wetland connectivity are more appropriately defined using a probability approach (see Recommendation 2.1). The Subcommittee recognizes that translating the complex science based on probabilities into discrete classifications requires both science and policy perspectives.

Specific Suggestions:

- Because the existing regional datasets (e.g., NWI and NHD) are capable of accurately identifying a large percentage of the jurisdictional waters, it is critical that these data be updated and improved to the extent possible. Therefore, the Subcommittee encourages continued participation in interagency efforts to refine the national datasets.
- Prioritize development of high-resolution data and models that reduce uncertainty in estimates of stream channel origins and the extent/frequency of connectivity of adjacent wetlands in areas that represent the greatest need and threat, based on input from targeted end users (OW, USACE).
- The Subcommittee suggests that SSWR further engage USACE practitioners to better define gaps in specific knowledge and tools, identify any existing working USACE methodologies/guidance, and target case studies and methods development to problems that most urgently need solving. The Subcommittee also suggests expanding stakeholder engagement, where it makes sense to do so, with additional federal partners (e.g., the National Oceanic and Atmospheria Administration, or NOAA) as well as academic partners that may assist in the refinement of hydrologic models to predict probability of flooding in adjacent wetlands under a range of flow regimes. The Subcommittee also sees value in exploring partnership or knowledge-sharing through existing or new networks with non-U.S. partners (e.g., scientific developments in the European Union to support the new Water Framework and Floods Directives).
- The Agency's current focus on high resolution models to explore case studies is anticipated to provide valuable insight into site-specific hydrologic regimes. To make this information more relevant nationally, the Subcommittee suggests that the Agency document and publish methods and information needed for scaling the analytical processes to regional or national models for future applications.

## Recommendations

The Subcommittee offers the following recommendation to support the relevant Agency priorities:

**Recommendation 2.1:** Hydrologic regimes are characterized by a continuum rather than discrete states. Therefore, the Subcommittee recommends the use of probabilistic metrics as a more accurate way to represent "real world" hydrological conditions to inform discrete classification approaches. The Subcommittee encourages the Agency to quantify uncertainties in both the underlying datasets as well as their applications. This will help with research prioritization and provide a more quantitative way to communicate success, progress, and key limitations among stakeholders.

***EPA Response:***

*SSWR agrees with this recommendation and we recognize the importance of characterizing dynamic stream networks via probabilistic metrics to inform stream classifications. Our ongoing research aims to understand, measure, and model stream and wetland variability and place that in context with more traditional classification approaches. Including probabilistic metrics also helps make possible the ability to address uncertainty and convey the annual variability that exists in these systems. As SSWR continues discussions with its federal partners, we aim to support this probabilistic approach to measure, understand, and visualize variability and uncertainty.*

## Charge Question 3

Q.3: To help reduce health risks associated with exposure to fecal contaminants in recreational waters, SSWR is conducting research to strengthen the scientific basis of existing, and to advance new, fecal contaminant detection methods, source tracking, predictive tools, and health effects assessments that contribute to human health recreational water quality criteria programs. As the research progresses, what suggestion(s) or recommendation(s) does the Subcommittee offer on continuing to identify and conduct research of greatest importance to advancing human health protection from fecal contaminants in recreational waters? [Research Area 3, Output 1]

**Narrative**

Almost 100 million people swim in oceans, lakes, rivers, or streams each year, making it among the most popular recreational activities in the United States. When those waters are contaminated, particularly with human or animal feces, the associated pathogens are known to cause various health risks, including gastrointestinal, respiratory, ear, eye, and skin infections. EPA has broad responsibilities to protect water quality in recreational waters, and ORD has the charge to develop monitoring and assessment tools that allow OW to achieve those goals.

ORD has a long history of successfully executing that role. They have been instrumental over the last two decades in transitioning the Agency from the use of hundred-year-old culture-based measurement methods to more modern genetic-based methods. These genetic methods are more reliable and more rapid, shortening the time to measure from days to hours. They have also extended these molecular techniques to use genetic signatures as a means of source identification, allowing managers to differentiate whether the fecal contamination at a site originated from human or animal sources. Finally, ORD has conducted the epidemiological studies that produce health-risk relationships for these new methods, allowing the OW to set management guidelines that are appropriately protective of human health.

The overall goal of this SSWR research area is to provide OW with information and tools needed for establishing and updating criteria – including recreational water quality criteria, future updates of human health criteria, and future revisions to aquatic life criteria. Charge Question 3 asked the Subcommittee to focus specifically on work with data and innovative tools to advance public health protection from microbial contaminants in surface waters. In their presentation to the Subcommittee, SSWR researchers described a strong portfolio of research, including studies to enhance the performance of molecular methods for existing indicators, development of new indicators, and expansion of microbial source identification techniques. In addition, they described studies to assess the prevalence of antimicrobial resistance to evaluate whether that is an important area for EPA to focus, and new forecast modeling techniques that allow for predictions of water quality issues at a site even before the physical measurements are made. The Subcommittee endorses all these research areas as appropriate to ORD and of value to the nation.

**Strengths**

The Subcommittee is impressed by the research group that SSWR has assembled to address this topical area and their accomplishments to date. There is no other research group in the world that is ahead of them technically in this field. More importantly, they have successfully transitioned their work from the laboratory to practice, as OW has promulgated new water quality criteria and promoted new associated assessment techniques based on their research.

One of the key means SSWR has employed to achieve that success is through strategic partnerships, which they emphasized in their presentation, and for which they should be commended. Some of those partnerships are with other research institutions, particularly with academia, as they draw the best minds in the nation to help them address their research objectives. The success of those partnerships is reflected in the large number of collaborative publications with other institutions. However, their emphasis on partnership also extends to working closely with end-users, such as states and tribes. Ultimately, OW is more likely to make use of their products when there is consensus among the user community that these tools can be implementable by the typical practitioner and add real value to the management process. By working with the local community to employ those tools in demonstration programs in various geographies, SSWR has been successful in creating interest and an awareness of these state-of-the-art techniques.

The molecular tools that SSWR has developed have gained widespread traction in the user community. However, there does not yet exist an agreed-upon means for assessing whether the techniques are being properly utilized at the wide array of public and private laboratories that are now implementing them. As their use transitions from exploratory public health warning systems to regulatory applications, there is a need for programs, such as the National Environmental Laboratory Accreditation Program, to establish and implement laboratory accreditation protocols for genetic-based measurement methods. The development of a certified reference DNA material will be an important step in that direction. To the extent possible, SSWR is encouraged to support efforts by the National Institute of Standards and Technology or private organizations to create a certified reference DNA material.

While the Subcommittee feels that all of the research that SSWR has proposed is appropriate to the Agency, the Subcommittee concluded the research focus that has the most opportunity for impact is the further development of methods for the detection and quantification of coliphages as indicators of fecal contamination in surface waters. Coliphage has some potential advantages over current fecal indicator bacteria that are the focus of present water quality criteria. It may be less prone to false signals from regrowth in the environment and can more closely mimic the survival of some pathogenic viruses after disinfection. OW has suggested that they are interested in potentially adding coliphage as an additional

water quality criteria indicator. This potential improvement in monitoring, and the renewed interest by OW, provides a tremendous opportunity for SSWR to impact the direction of the Agency's water quality criteria and, again, successfully transition from research to application.

**Suggestions**

One of the challenges with the use of genetic measurement techniques is that genetic fragments can persist in the water column long after the viability of the targets they represent has faded. Use of these tools would benefit from a better understanding of the relative survival of the pathogens and the genetic material that is now being quantified.

Regrowth in the environment of the indicators EPA uses can provide a false positive signal about the presence of fecal contamination. SSWR should help improve understanding of this regrowth process, such as what moisture, temperature and nutrients conditions cause such regrowth. Concern related to source(s) and causes of microbial blooms affecting recreational waters are explored and would complement other forensic details gathered when such events are investigated.

### Recommendations

The Subcommittee offers the following recommendation to support the relevant Agency priorities:

**Recommendation 3.1:** The Subcommittee was charged with identifying the research of greatest importance to advancing human health protection from fecal contaminants in recreational waters, and it feels that while all of the research SSWR has proposed is appropriate, the research focus that has the most significant opportunity for impact and should be prioritized is the further development of methods for the detection and quantification of coliphages as indicators of fecal contamination in surface waters.

***EPA Response:***

*SSWR agrees with this recommendation. Science to support the potential use of coliphage as an indicator for recreational water quality monitoring is a high priority for our partners. Our current research activities focus on 1) a large-scale method evaluation of a coliphage protocol (developed by EPA) in different water body types, 2) temporal and spatial trends in coliphage measurements across different recreational settings, 3) the incidence of coliphage in untreated wastewater collected from facilities across the contiguous United States, 4) the influence of sunlight on coliphage survival in the recreational environment, 5) coliphage-based water quality forecasting for freshwater recreational beaches, 6) the co-occurrence of coliphage and microbial source tracking genetic markers at recreational beaches, and 7) coliphage transport modeling at a Great Lakes beach. These efforts are being conducted in collaboration with more than 100 local and state partners. Future research activities will build upon findings from current efforts and will continue to be responsive to the BOSC Subcommittee's recommendation and EPA partner and stakeholder needs.*

## SUMMARY LIST OF RECOMMENDATIONS

### Charge Question 1: Progress towards characterizing microplastics in the environment and uncertainties about their potential environmental health effects

requires reliable and consistent methods. SSWR is conducting research to develop and standardize collection, extraction, identification and quantification methods for microplastics. Based on the progress and results to date, what suggestion(s) or recommendation(s) does the Subcommittee offer on research into addressing the uncertainties and challenges associated with the Agency's efforts to develop reliable and consistent microplastics analytical methods? [Research Area 1, Output 4]

- **Recommendation 1.1:** Measurement methods to characterize microplastics is the appropriate starting point. SSWR should begin work now towards developing a strategy for incorporating both environmental and human health effects into the next StRAP.

Charge Question 2: Existing geospatial datasets are often limited with respect to mapping rivers, streams, and wetlands with the degree of accuracy and at the resolution needed to support federal, state, tribal, and local water management decisions, including identifying "waters of the United States" subject to Clean Water Act jurisdiction. SSWR is leveraging existing interagency partnerships to improve the accuracy and application of geospatial data for mapping aquatic resources nationally. What suggestion(s) or recommendation(s) does the Subcommittee offer on further identifying emerging technologies, methodologies, and datasets to improve aquatic resource mapping tools and their application for federal, state and local water management decisions? [Research Area 2, Output 1]

- **Recommendation 2.1:** Hydrologic regimes are characterized by a continuum rather than discrete states. Therefore, the Subcommittee recommends the use of probabilistic metrics as a more accurate way to represent "real world" hydrological conditions, to inform discrete classification approaches. The Subcommittee encourages the Agency to quantify uncertainties in both the underlying datasets as well as their applications. This will help with research prioritization and provide a more quantitative way to communicate success, progress, and key limitations among stakeholders.

Charge Question 3: To help reduce health risks associated with exposure to fecal contaminants in recreational waters, SSWR is conducting research to strengthen the scientific basis of existing, and to advance new, fecal contaminant detection methods, source tracking, predictive tools, and health effects assessments that contribute to human health recreational water quality criteria programs. As the research progresses, what suggestion(s) or recommendation(s) does the Subcommittee offer on continuing to identify and conduct research of greatest importance to advancing human health protection from fecal contaminants in recreational waters? [Research Area 3, Output 1]

- **Recommendation 3.1:** The Subcommittee was charged with identifying the research of greatest importance to advancing human health protection from fecal contaminants in recreational waters, and it feels that while all of the research SSWR has proposed is appropriate, the research focus that has the most significant opportunity for impact and should be prioritized is the further development of methods for the detection and quantification of coliphages as indicators of fecal contamination in surface waters.

# APPENDIX A: MEETING AGENDA

**Day 1: Wednesday October 28, 2020, Eastern Daylight Time**

| Time (EDT) | Topic | Presenter |
|---|---|---|
| 11:45-12:00 | Sign on & Technology Check | |
| 12:00-12:15 | Welcome and Opening Remarks | Tom Tracy (DFO)<br>Joseph Rodricks (BOSC SSWR Chair)<br>Robert Blanz (BOSC SSWR Vice Chair) |
| 12:15-12:30 | ORD Welcome | Jennifer Orme-Zavaleta<br>(ORD Principal DAA for Science) |
| 12:30-12:40 | SSWR Overview and Charge Questions | Suzanne van Drunick (SSWR NPD) |
| 12:40-1:00 | ORD Overview – Centers | Tim Watkins (Director, CEMM)<br>Wayne Cascio (Director, CPHEA) |
| 1:00-1:10 | Watersheds Introduction | Rick Greene (Watersheds Topic Lead) |
| 1:10-2:10 | Overview of Research Area 1: *Assessment, Monitoring and Management of Aquatic Resources*<br>• Output 1: National Aquatic Resource Survey (NARS) Support<br>• Output 2: NARS Extension<br>• Output 3: Biological Indicators<br>• Output 5: Water Quality Benefits<br>• Output 6: San Juan Watershed Support | Brenda Rashleigh (ACD, CPHEA)<br><br>Steve Paulsen (CPHEA) Peg Pelletier (CEMM) Susan Yee (CEMM) Matt Heberling (CEMM) Kate Sullivan (CEMM) |
| 2:10-2:30 | BOSC questions on Research Area 1, Outputs 1-3 and 5-6 | Joe Rodricks, Robert Blanz<br>(BOSC Chairs) |
| 2:30-2:45 | Break | |
| 2:45-3:15 | Research Area 1, continued<br>• **Output 4: Microplastics** | Kay Ho (CEMM) |
| 3:15-3:30 | EPA's international efforts on plastics in marine litter | Jane Nishida (Principal Deputy AA, OITA) |
| 3:30-4:15 | BOSC questions on Research Area 1, Output 4, **Charge Question 1** | Joe Rodricks, Robert Blanz<br>(BOSC Chairs) |
| 4:15-4:30 | Public Comments | Tom Tracy (DFO) |
| 4:30-5:00 | BOSC Discussion | Joe Rodricks, Robert Blanz<br>(BOSC Chairs) |
| 5:00-5:15 | Wrap up | Joe Rodricks, Robert Blanz<br>(BOSC Chairs) |
| 5:15 | Adjourn | |

**Day Two: Thursday October 29, 2020, Eastern Daylight Time**

| Time (EDT) | Topic | Presenter |
|---|---|---|
| 11:50-12:00 | Sign on & Technology Check | |
| 12:00-12:10 | Welcome – Day 2 | Tom Tracy (DFO)<br>Joseph Rodricks (BOSC SSWR Chair)<br>Robert Blanz (BOSC SSWR Vice Chair) |
| 12:10-12:30 | ORD Overview – Centers | Rusty Thomas (Director, CCTE)<br>Greg Sayles (Director, CESER) |
| 12:30-1:00 | Overview of Research Area 2: *Improved Aquatic Resource Mapping*<br>• **Output 1: Improved Accuracy and Application of Geospatially Explicit Aquatic Resource Data** | Brenda Rashleigh (ACD, CPHEA)<br><br>Jay Christensen (CEMM) |
| 1:00-1:45 | BOSC questions on Research Area 2, **Charge Question 2** | Joe Rodricks, Robert Blanz (BOSC Chairs) |
| 1:45-2:00 | GEMMD Virtual Lab Tour | |
| 2:00-2:15 | Break | |
| 2:15-2:35 | Overview of Research Area 3: *Human Health and Aquatic Life Criteria*<br>• Output 2: Human Health and Chemical Contaminants<br>• Output 3: Aquatic Life Criteria | Ann Grimm (ACD, CEMM)<br><br>Adam Biales (CCTE)<br><br>Russ Erickson (CCTE) |
| 2:35-2:50 | BOSC questions on Research Area 3, Outputs 2 and 3 | Joe Rodricks, Robert Blanz (BOSC Chairs) |
| 2:50-3:20 | Research Area 3, continued<br>• **Output 1: Human Health and Recreational Water Quality** | Orin Shanks (CEMM) |
| 3:20-4:15 | BOSC questions on Research Area 3, **Charge Question 3** | Joe Rodricks, Robert Blanz (BOSC Chairs) |
| 4:15-4:30 | Public Comments | Tom Tracy (DFO) |
| 4:30-5:15 | Charge Question Break-out Groups (committee members will be preassigned to specific charge questions) | Joe Rodricks, Robert Blanz (BOSC Chairs) |
| 5:15-5:30 | BOSC Discussion/Next Steps | Joe Rodricks, Robert Blanz (BOSC Chairs)<br>Suzanne van Drunick (NPD)<br>Tom Tracy (DFO) |
| 5:30 | Adjourn | |

# APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

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

- Agenda
- Charge questions
- SSWR Draft StRAP FY 2019–2022

***Informational Materials***

- Virtual Participation Guide
- Research Area 1 Overview Presentation
- Research Area 1.4 Presentation
- Research Area 2 Overview Presentation
- Research Area 3 Overview Presentation
- Research Area 3.4 Presentation