EPA Research Partner Support Stories

August 2023 Update





US EPA Research Supporting States

Addressing State Environmental Research Needs

The success of environmental protection and public health in the United States begins on the front lines at the state, tribal and local levels. US EPA's Office of Research and Development (EPA ORD) is a vital scientific and technical resource to states, territories, tribes and communities, providing the technical support and training, science-based tools, and innovative approaches and methods they need to meet their highest priority environmental and related public health challenges, while also laying the groundwork for long-term health and prosperity.

This document compiles summaries of how EPA ORD's work during the past several years, in partnership with state and territorial agencies, tribes, counties, communities and universities, has supported partners' efforts to protect human health and the environment. These stories highlight a wide range of research, development, decision support tools and technical assistance efforts focusing on air and water pollution, chemicals, Superfund and other contaminated site remediation, infrastructure, and homeland security – all of which are critically important to helping states, tribes and communities address their highest priority, on the ground environmental challenges. Each story includes a brief testimonial from a leader in the state, tribe or community to whom we provided support.

Collaboration and teamwork with state and territorial environmental and health agencies in particular have made it possible to better achieve the mission of protecting human health and the environment. EPA ORD has developed critical partnerships to ensure our work is relevant to real-world environmental challenges and that scientific findings and tools are delivered to decision makers in ways that make them immediately accessible and useful. EPA ORD has partnered with the Environmental Council of the States (ECOS, the national association of state environmental agency leaders) and its research arm—the Environmental Research Institute of the States (ERIS)—and the Association of State and Territorial Health Officials (ASTHO, the national association of state and territorial chief health officials) to ensure that our science and engineering efforts are useful and practical for those working at the intersection of the environment and public health. EPA ORD will continue to work directly with the states and territories to advance our shared mission to protect the public's health from environmental threats and hazards and to advance health and environmental equity for all.

Our partners provide significant insights into the environmental challenges they face and how EPA can best translate our science into well-informed decision tools for states, tribes and communities. Over the past several years, ECOS/ERIS, ASTHO and EPA ORD have strengthened the alignment of EPA's scientific and technical capabilities with state research priorities and needs through a series of meetings (including some tribes) and state surveys. As a result of this effort, EPA ORD better understands the science needs of state environmental and health agencies, and states better understand EPA ORD's research, tools, and role within EPA. In 2022, state environmental agencies identified their top challenges that could benefit from additional research, including PFAS, air quality, drinking water, water quality, waste and remediation, adaptation, and cross-media. EPA ORD values the information our state partners provide as it will help us to conduct research where it is most needed.

We look forward to continuing to strengthen our partnership with ECOS/ERIS, ASTHO, tribes and other partner groups to develop the science and engineering solutions to address their immediate and long-term needs.

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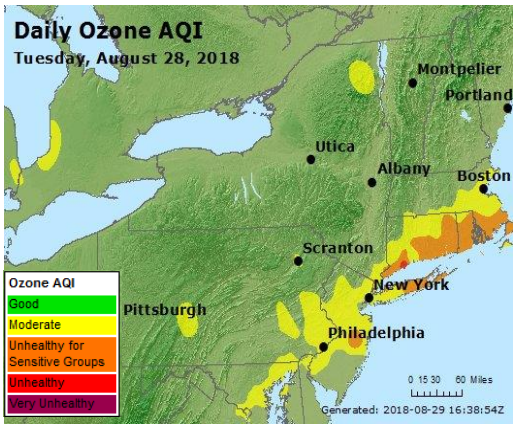
AIR – OZONE AND PARTICULATE MATTER

Partners: Northeast States for Coordinated Air Use Management (NESCAUM), Connecticut Department of Energy and Environmental Protection (CTDEEP), New Jersey Department of Environmental Protection (NJDEP), New York State Department of Environmental Conservation (NYSDEC), New York State Energy Research and Development Authority (NYSERDA)
Challenge: Better understanding the causes of ground-level ozone formation and transport in the New York City metropolitan area
Resource: Deployment of advanced air quality monitoring tools at eight sites as part of the Long Island Sound Tropospheric Ozone Study (LISTOS) and subsequent data analysis in collaboration with NASA, NOAA, University of Maryland, SUNY-Albany, SUNY-Stony Brook, City College of New York, and Yale University
Project Period: 2018 – Present



"ORD's coordination with and support of LISTOS has helped New York better understand precursors of ground level ozone in the New York City area so that we will be able to better address it." – NYSDEC Division of Air Resources Research Scientist Dirk Felton

Surface-level ozone is formed when nitrogen oxides and volatile organic compounds react with one another in the presence of sunlight. While air pollution levels have dropped over the years across the United States, the New York City (NYC) metropolitan area and surrounding region continue to persistently exceed both past and recently revised federal health-based air quality standards for ground-level ozone.

To better understand and address this challenge, EPA scientists collaborated in a multi-agency field study in spring and summer 2018 called the Long Island Sound Tropospheric Ozone Study (LISTOS). Data collected during LISTOS provided scientists and decision makers more detailed information on the sources of ground-level ozone photochemical formation and its transport downwind of NYC. Measurement assets supporting this field study included a combination of aircraft and ground-based measurements from numerous research organizations.

The main part of the study ran from June – August 2018, but many ORD supported measurements are continuing in collaboration with the states to address their need to develop and carry out an enhanced monitoring plan with EPA. Since the summer of 2018, information garnered from the study and its subsequent analysis have help guide discussions about emission control scenarios for reducing ground-level ozone formation with the aim of eventually meeting the national standards.

For more information on the Long Island Sound Tropospheric Ozone Study, go to the Northeast States for Coordinated Air Use Management webpage.

Partners: Wisconsin Department of Natural Resources (DNR), Lake Michigan Air Directors Consortium (LADCO)
Challenge: Better understanding ozone formation and transport impacting the shorelines of Lake Michigan
Resource: Advanced air quality monitoring methods deployed at various sites across Lake Michigan's western shorelines, including on-board federal research vessel in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and research groups at NASA, the University of Iowa, the University of Northern Iowa, the University of Minnesota, the University of Wisconsin via the National Science Foundation, and the Electric Power Research Institute (EPRI)
Project Period: 2017 – Present

"This study will improve the models that we use to inform science-based decision making."
– Wisconsin DNR Pat Stevens (former Assistant Deputy Secretary and division administrator)

Ozone is formed when compounds such as nitrogen oxides (NOx) and volatile organic compounds (VOCs) react with sunlight. Despite dramatic reductions in these ozone precursor emissions, many areas bordering Lake Michigan continue to experience elevated ozone concentrations. This long-standing issue is one of the more challenging air quality issues in the eastern U.S.

A problem that is hindering states and stakeholders addressing this challenge is associated with the formation of ozone over Lake Michigan and the complex interaction of the meteorology and ozone chemistry, including the transport of ozone and ozone precursors in the region, which are not completely understood. Photochemical models are important tools for understanding such transport issues. However, these models historically have been unable to reproduce the lake breeze effect present around Lake Michigan, making it difficult for states, the LADCO and EPA to accurately predict and address ozone concentrations along the Lake Michigan lakeshore. LADCO is a regional planning organization that includes representation from Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin

In the summer of 2017, EPA ORD, LADCO, academic and private institutions, and other state and federal agencies pooled their expertise and resources to commence a field study to collect information that will be used to better inform air quality models and improve the scientific understanding of ozone formation around Lake Michigan. EPA ORD, in conjunction with NOAA and NASA, outfitted a NOAA research vessel with EPA instruments to support over-the-water measurements. NASA and EPRI are providing airborne remote sensing measurement to complement EPA and state surface measurements to help understand pollutant transport over Lake Michigan. These measurements will be combined with satellite data to better understand ozone chemistry and transport over the area, and better inform efforts to reduce ozone formation along the shoreline.

All study data have been posted in a public archive, and the science team published a synthesis report in April 2019 and several peer-reviewed publications. Numerous modeling studies are being conducted by external collaborators and by EPA's Office of Air Quality Planning and Standards and Region 5. The study data are being used by LADCO and the University of Wisconsin to establish a Weather Research and Forecasting (WRF)-Community Multiscale Air Quality (CMAQ) modeling configuration for ozone State Implementation Plan modeling. EPA ORD continues to participate in Enhanced Ozone Monitoring activities with Wisconsin DNR in 2021.

Partner: Utah Department of Environmental Quality (DEQ)
Challenge: Fine particle air pollution
Resource: Ground-based and remote sensing air measurements for the Utah Winter Fine Particulate Study in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and other partners
Project Period: 2017 – 2018

"The in-kind funding EPA provided, including the sophisticated instrumentation, lab analysis and project management support, was invaluable in making [the 2017 Utah Winter Fine Particulate Study] a success. The nature of fine particle pollution during northern Utah's periodic winter inversions presents a complex scientific problem [which Utah] has been analyzing for many years, and the insight and technical expertise of EPA researchers will certainly help in our efforts to tackle this difficult problem. We are hopeful the measurements and analysis of the complex atmospheric chemical reactions this study captured will enhance our ability to create effective policy tools to improve Utah's air quality during these winter episodes." – Utah DEQ Alan Matheson (former Executive Director)

During the winter in Utah's northern valleys, cold air inversions trap pollution emitted from vehicles, industry and agriculture. This allows atmospheric chemicals to mix and leads to the formation of fine particulate matter ($PM_{2.5}$), which is an air pollutant that is harmful to health when it is concentrated at high levels.

In 2017, EPA ORD provided support to Utah in its Utah Winter Fine Particulate Study (UWFPS) – one of the most comprehensive efforts to date to determine the chemical processes in the atmosphere that lead to the formation of $PM_{2.5}$. During January and February, ORD scientists collected ground-based air measurements using new techniques they developed in the lab and remote sensing technology. The data were combined with measurements of the upper atmosphere taken by NOAA using aircraft to obtain a complete analysis of atmospheric chemistry in the valleys.

The science team collaborated on a report on study findings that was delivered to the state of Utah in spring 2018. Information from the study will help to improve air quality for the more than two million residents who live in the area.

AIR – QUALITY

Partners: Arkansas Department of Environmental Quality (ADEQ), Arkansas Department of Health (ADH)
Challenge: Underground fire at abandoned dumping site sparks public health risks
Resource: Technical assistance and environmental monitoring
Project Period: 2018 – 2019

"*The ability to access EPA's Office of Research and Development (ORD) resources and expertise is critical for state response efforts. Arkansas appreciates continuing work with EPA to close the gaps on environmental challenges and to address community concerns."*
– Arkansas Director of Energy and Environment Secretary Becky Keogh

In July 2018, residents of Bella Vista, Arkansas noticed a dull haze and the smell of smoke wafting through their community and seeping into nearby homes and businesses. The source of their concern turned out to be a smoldering underground fire at a former illegal dumping site. Two former owners of the property had turned it into a kind of unofficial (and unmonitored) dump, allowing nearby residents to dispose of brush, wood, and other organic material. Unfortunately, according to numerous news reports it is now clear that old car batteries, wiring, and old pool liners were also discarded. Subsequently buried - the whole mess was out of sight, out of mind. That was until smoke started rising from the ground.

Locally known as "the stump dump fire" the conflagration has continued to smolder for more than half a year, sparking health concerns and attracting the attention of ADEQ and ADH, as well as elected officials including a congressman and both Arkansas senators. Together, they called on EPA for help.

To date, EPA has provided resources to the state for air monitoring, legal advice, and engineering tactics to assist the state in controlling the fire. Arkansas's congressional delegation along with the local and state officials acknowledge and appreciate this assistance as well as the technical assistance provided by the EPA Region 6 (South Central) Office in Dallas, Texas," noted Arkansas Congress Member Steve Womack and Arkansas Senators Tom Cotton and John Boozman in a letter to the EPA Administrator asking for additional assistance.

That assistance included significant technical and scientific support from EPA ORD, part of an ongoing partnership to match ORD expertise and resources with high priority needs in the states. ORD engineers have visited the burning stump dump site to assess conditions and gather information and contributed to an assessment of ongoing management approaches and mitigation options. ORD also provided comments on the ADEQ Draft Response Action Plan and has also been assisting ADEQ with responding to questions the State has received from the plan.

EPA researchers will continue to work closely with the State as officials to continue to monitor air quality and other conditions and provide expert advice as they decide on the best course for minimizing additional risks and move forward with plans to extinguish the fire and revitalize the site.

Partners: Environmental Law and Policy Center (ELPC) and Morton Arboretum with support from Illinois Department of Transportation, City of Chicago, Chicago Public Schools, Chicago Metropolitan Agency for Planning
Challenge: Near-road air pollution exposure in vulnerable student populations
Resource: Tools and technical support to mitigate near-road air pollution with strategically placed vegetative barriers
Project Period: February 2020 – August 2021

A Chicago school, as depicted in a base map, overlaid with the EnviroAtlas near-road tree

"EPA's technical support has been invaluable to assessing which area schools could have safer, cleaner air by installing a vegetative buffer. We look forward to continuing the collaboration through successful implementation." – Environmental Law & Policy Center Senior Policy Advocate Susan Mudd

Numerous health studies show that people who live, work and go to school near large roadways and transportation facilities face increased health risks from air pollution exposure, including asthma and other respiratory diseases, cardiovascular effects, cancer and premature mortality.

EPA ORD researchers are working with partners in Illinois to use the Agency-developed EnviroAtlas and the report Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality to improve air quality for schools located near major roadways.

EnviroAtlas is a robust, interactive web-based resource that provides geospatial data, easy-to-use tools, and other resources that help users identify and incorporate aspects of the natural environment to improve public health.

EPA scientists consulted with the partners on using green infrastructure to mitigate near-road air pollutant exposure in vulnerable student populations. They provided a virtual demonstration of EnviroAtlas' fine-scale data availability, and ELPC identified Chicago schools within 200 meters of major expressways and assessed those school sites with respect to existing near-road tree cover. EPA researchers also developed a list of factors for partners to consider for identifying and prioritizing schools that may benefit from vegetative barriers to improve air quality. Next, the project will enter the tree-planting stage, a collaboration with EPA ORD and EPA Region 5 and an ever-widening group of city and state supporters.

EnviroAtlas is publicly accessible at https://www.epa.gov/enviroatlas.

Partners: Participating pilot locations including the cities of Chicago, IL; Durham, NC; Hartford, CT; Houston, TX; Kansas City, KS; Oklahoma City, OK; Philadelphia, PA and Washington, DC
Challenge: Air quality monitoring for community awareness
Resource: Village Green Project
Project Period: 2014 – 2019

" The Village Green station is a helpful tool in educating the public, and particularly children, about the importance of air quality in our everyday lives. We are thankful to be one of several cities across the country to have such an innovative tool." – Oklahoma DEQ Executive Director Scott Thompson *(referring to the Village Green Project in Oklahoma City)*

The Village Green Project (VGP) was a novel air and weather measurement station originally developed by EPA ORD scientists. The station is a compact, solar-powered system that incorporates air and weather instrumentation into a park bench. The project built upon the need to enhance transparency and showcased next-generation air measurement technology by providing quality-assured data to the public on a near real-time basis, updating to a public data website every minute.

The original prototype was field-tested outside a public library in Durham, NC. Following the successful prototype test, EPA created a pilot VGP expansion and engaged with state, local and tribal agencies in placing new park bench stations in various community environments. Eight Village Green stations were established in the U.S. located in a variety of environments selected by the grant recipients, such as libraries, a public garden, and high foot-traffic tourist areas. In addition to Oklahoma City, OK and Durham, NC, participating cities included Philadelphia, PA, Hartford, CT, Kansas City, KS, Washington, DC, Chicago, IL, and Houston, TX. The state and local agencies have used the stations as an opportunity to host public outreach events, including ribbon-cutting ceremonies and informational sessions. Now that the project is complete, all of the benches, with the exception of the Durham bench, have been transferred to the project partners. Some of the stations are still operating and information on all the stations is still available on the Village Green Project webpage.

Select Additional Resources:

- Report: Village Green Design, Operations, and Maintenance Document
- EPA Science Matters Article: Village Green Project Air Monitoring Stations A Success
- The Village Green Project: Lesson Plans for K-8 Educators

Partners: Utah Department of Environmental Quality (DEQ), Colorado Department of Public Health and Environment (CDPHE), West Virginia Department of Environmental Protection (WVDEP), oil and gas cooperators
Challenge: Support efficient development of U.S. energy resources while protecting human health
Resource: Next generation measurement methods
Project Period: 2016 – Present

"EPA ORD has been a valuable partner in our efforts to advance needed energy development while improving air quality in the Uinta Basin."
– Utah DEQ, Alan Matheson (former Executive Director)

Oil and natural gas production have increased significantly within Utah's Uinta Basin, Colorado's Denver-Julesburg Basin, West Virginia's Marcellus Shale, and across the United States over the last decades. Approximately three-quarters of the production in the Uinta Basin is on Indian Country within the Uintah and Ouray Reservation. Oil and natural gas extraction and production activities co-emit volatile organic compounds, and greenhouse gases directly to the atmosphere. Industry, regulators and communities have shared interests in understanding and minimizing sources of harmful air emissions from oil and gas production activities.

EPA ORD researchers in collaboration with Region 8 (Mountains and Plains) are working with Utah and Colorado state officials and oil and gas operators to conduct emissions research on pneumatic controllers used in upstream production. Pneumatic controllers provide process control and safety functions and emit natural gas to the atmosphere. Because of the very large number of these devices, they contribute significantly to air emissions, however some uncertainty remains regarding the real-world emissions from these devices. In 2016, research was conducted in cooperation with oil and gas operators in the Uinta Basin, Utah, on assessing emissions from pneumatic controllers using next generation measurement methods. In 2018, EPA ORD worked with CPDHE to conducted field surveys of pneumatic controller emissions in the Denver-Julesburg Basin. Currently, EPA ORD is performing cooperative research with Region 3 (Mid-Atlantic) and a Marcellus Shale oil and gas operator on emission measurements and inventory analysis of production in West Virginia, providing useful data to WVDEP for pneumatic controller and other emission sources.

The ongoing collaboration between EPA, the states of Utah, Colorado, West Virginia, and oil and gas operators will improve understanding of these devices and measurement methods, and ultimately support better development of U.S. energy assets in ways that also protect human health and the environment.

Additional resources:

- Understanding Oil and Gas Pneumatic Controllers in the Denver-Julesburg Basin using Optical Gas Imaging (published 2020)
- Assessment of Uinta Basin Oil and Natural Gas Well Pad Pneumatic Controller Emissions (published 2018)
- Advancing Understanding of Emissions from Oil and Natural Gas Production Operations to Support EPA's Air Quality Modeling of Ozone Non-Attainment Areas; Final Summary Report (published 2016)

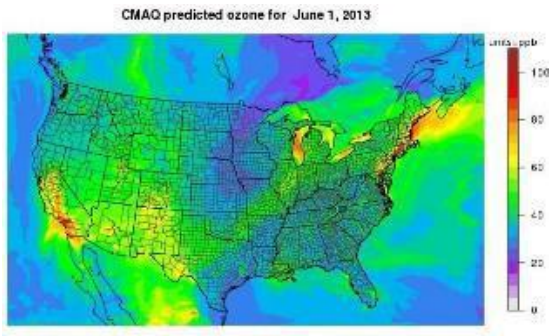
Partners: Northeast States for Coordinated Air Use Management (NESCAUM), an association of eight Northeastern States including Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont
Challenge: Northeastern states' planning for energy and air emissions
Resource: Energy system database
Project Period: 2005 – 2016

"*EPA ORD, through its research programs, is well-positioned to support us in better understanding the numerous multi-state origins and inter-state transfer of air pollution and how it evolves as it travels to Rhode Island. No individual state in the Northeast is capable of studying this complicated issue alone."* – Rhode Island Department of Environmental Management former Director Janet Coit

The MARKet ALlocation (MARKAL) tool is used to model the nation's energy system and evaluate different energy technology options for reducing air quality emissions. The tool uses energy and water technology data to create future scenarios or options for optimizing water and energy consumption and management. City planners can run simulations on a variety of policy options to evaluate the most cost-effective and environmentally sustainable solutions for providing energy- and water-related services such as heating, cooling, and water and wastewater treatment.

EPA ORD collaborated with NESCAUM in the further development of a MARKAL model tailored specifically to the energy infrastructure of the Northeast. This NE-MARKAL model was based on ORD's U.S.-scale 9 region MARKAL/TIMES optimization model database used by decision makers for coordinated energy and air emissions planning. ORD provided expertise and support for the development of state-level model database(s) and implementation of the modeling framework and case studies. The NE-MARKAL framework can be used by decision makers to examine energy policy options and their resultant impacts on energy services in the region.

Partners: California Air Resources Board, Georgia Environmental Protection Division, Maryland Department of the Environment, New Jersey Department of Environmental Protection, New York State Department of Environmental Conservation, North Carolina Department of Environmental Quality, Utah Department of Environmental Conservation, Virginia Department of Environmental Quality, San Joaquim Valley Unified Pollution Control District, South Coast Air Quality Management District
Challenge: Need for effective strategies to reduce harmful air pollutants
Resource: EPA's Community Multiscale Air Quality (CMAQ) Modeling System
Project Period: 2005 – Present



"Maryland has made dramatic progress over the past 10 years in reducing ozone and fine particle pollution. We have invested heavily into research and modeling and this investment has been one of the reasons we have been successful. The CMAQ photochemical model has been the key tool we have used to design and refine control strategies. It has helped us find least cost solutions to reduce ozone and fine particle pollution." – ECOS Executive Director Ben Grumbles (former Secretary, Maryland Department of the Environment)

For more than 15 years, EPA and states have been using EPA's Community Multiscale Air Quality (CMAQ) Modeling System, a powerful computational tool for air quality management. CMAQ simultaneously models multiple air pollutants, including ozone, particulate matter, and a variety of air toxics to help air quality managers determine the best air quality management scenarios for their states and communities.

State agencies that control air pollution use CMAQ to develop and assess implementation actions needed to attain National Ambient Air Quality Standards (NAAQS) mandated by the Clean Air Act. States use the tool to identify sources of air quality problems and to assist in the design of effective strategies to reduce harmful air pollutants. Using data about land use, meteorology, and emissions, CMAQ provides detailed information about the concentrations of air pollutants in a given area for any specified emissions or air quality scenario. With information generated by CMAQ, states are able to examine the estimated impacts of different air quality policies.

The National Weather Service also uses the model to produce air quality forecasts twice daily, and the Centers for Disease Control and Prevention use CMAQ data in two community-focused tools that allow users to access county-specific air quality information on pollutants, such as ozone and particulate matter.

The CMAQ modeling system is publicly available, undergoes rigorous scientific peer-review and is used worldwide (in over 125 countries) for air quality assessments and research. The system brings together three kinds of models including meteorological models to represent atmospheric and weather activities; emission models to represent man-made and naturally occurring contributions to the atmosphere; and an air chemistry-transport model to predict the atmospheric fate of air pollutants under varying conditions. The newest version of the model (CMAQ 5.4) was released in October 2022.

AIR – SENSORS

Partner: Maricopa County Air Quality Department
Challenge: Demonstrating the utility and challenges of using air sensors to investigate air quality issues in Phoenix, AZ
Resource: Reports, publications and presentations documenting the study and characterizing air sensor performance and air quality trends in Phoenix
Project Period: 2018 – 2021

Haze from air pollution in Phoenix, AZ. Inset: Sun damage to a PurpleAir sensor.

"The Maricopa County Air Quality Department was excited to work closely with EPA on this study. Developing an understanding of these new citizen science tools gives us the ability to help citizens put the data they are collecting into context. The data that were obtained in this study, and the expert analysis assistance provided by the EPA team, gave us a better understanding of the spatiotemporal patterns of $PM_{2.5}$. Furthermore, the knowledge gained on the use and limitations of these sensors will assist our agency with the future utilization of these affordable monitoring tools." – Ben Davis, Air Monitoring Division Manager, Maricopa County

A new generation of lower cost air sensors is increasingly being used by state, local and tribal agencies, researchers, citizen scientists and others to supplement regulatory monitoring at the neighborhood level. However, air sensor performance and data quality can vary based on local conditions, such as temperature, relative humidity, and composition of particles. As a result, there is a need to understand how sensors behave in different environments when using them to study local air quality.

During the Phoenix as a Testbed for Air Quality Sensors (PTAQS) project, EPA collaborated with the Maricopa County Air Quality Department (MCAQD) to deploy a network of PurpleAir fine particulate matter ($PM_{2.5}$) sensors across Phoenix. In Phase I (November 2018 – July 2019), multiple PurpleAir sensors were placed alongside more expensive and sophisticated regulatory monitors at three sites to study long-term sensor performance and data quality in Phoenix's hot, dry and sunny environment. In Phase II (July 2019 – March 2021), PurpleAir and black carbon sensor packages were built and deployed at 20 non-regulatory sites to study air quality trends across the city. A mobile trailer with regulatory-grade $PM_{2.5}$ measurements was also transported between sites to validate sensor calibration methods. MCAQD has provided important support by maintaining the sensor network, retrieving data, and sharing expertise on local air quality issues.

The PTAQS network is a great opportunity to understand air sensor performance in a new environment and answer specific air quality questions that have been challenging to address using the existing regulatory monitoring network alone. The work led to an increased density in observations that assisted interpolation of concentrations across the city, high time resolution data that can help visualize how pollutants move and how conditions can change during the day, additional supporting information for identifying exceptional events, and a greater understanding of how to correct and interpret data from air sensors.

Partners: Colorado Department of Public Health and Environment, Delaware Department of Natural Resources and Environmental Control, Georgia Environmental Protection Division, Oklahoma Department of Environmental Quality, Wisconsin Department of Natural Resources (DNR) and Maricopa County (AZ) Air Quality Department
Challenge: Harnessing advances and innovations in air sensor technology for protecting public health
Resource: Long-term performance evaluation of popular air sensor types at locations across the U.S.
Project Period: 2019 – 2021

"As technology and public interest in air quality measurements advance, inexpensive sensors are fast becoming data crowd sourcing tools as well as community outreach resources. Research on the performance of sensors compared to regulatory sensors will be very valuable to states and communities as they look to use these sensors to expand air monitoring opportunities across the country." – Wisconsin DNR, former Environmental Management Division Administrator Darsi Foss

There is wide interest from air monitoring agencies, researchers, and community groups in deploying smaller, more portable air sensor technologies for community-scale air monitoring projects. First, air sensors need to be thoroughly evaluated in order to understand their limitations and data quality. Many sensor evaluations performed to date have evaluated sensors for short time periods in a single site or region. To be valuable at the local level, more information is needed about how sensors perform long-term and under a wide variety of meteorological conditions and pollutant concentrations.

EPA partnered with six air monitoring agencies across the United States to operate five air sensor types alongside standard regulatory monitors so that data could be compared. The commercially available sensors reported concentrations of one or more pollutants and featured variation in sensing elements, sampling techniques, data communication, size, and data correction and display. Data were collected between summer 2019 and spring 2021.The research team shared initial observations and findings with partners and presented results at scientific conferences and during an external EPA webinar in August 2022. In addition, results will be posted on the Air Sensor Toolbox using EPA's recommended Performance Evaluation Reporting Template and in peer-reviewed scientific journals in 2023. Most importantly, the project illustrates some of the important considerations that should be considered for planning community monitoring projects using this class of technology, including variations in design and performance, common points of failure, suggestions for maintaining sensors for long-term operation, and awareness of the similarities and differences between different sensors and regulatory monitors. Ultimately, the goal is to help manufacturers improve their products, users to choose appropriate sensors for their intended applications, and for air quality managers to advance air quality data collection and accuracy.

More information on this project and air sensor research can be found on the Air Sensor Toolbox.

Partner: South Coast Air Quality Management District's (SCAQMD) Air Quality Sensor Performance Evaluation Center (AQ-SPEC) (CA)
Challenge: Understanding the utility and accuracy of low-cost air sensors to measure pollution
Resource: Deployment and testing of air sensors in real-world conditions
Project Period: 2016 – 2018

"The SCAQMD/AQ-SPEC collaboration with the US EPA on the Citizen Science Air Monitor (CSAM) evaluation project set the ground for the development of a sensor network across the South Coast Air Basin for the collection of $PM_{2.5}$, O_3, and NO_2 data with a high level of spatial and temporal resolution." – SCAQMD Advanced Monitoring Technologies Manager Andrea Polidori

Air pollution impacts can vary depending on geography, weather and proximity to pollution sources. For example, the Los Angeles metropolitan area often faces unhealthy air quality levels due to the unique weather, geography and variety of air pollution sources. Some vulnerable communities in the area are disproportionately impacted because of their proximity to busy roadways, ports, railyards, refineries, and other industrial facilities. This has raised public health and environmental justice concerns.

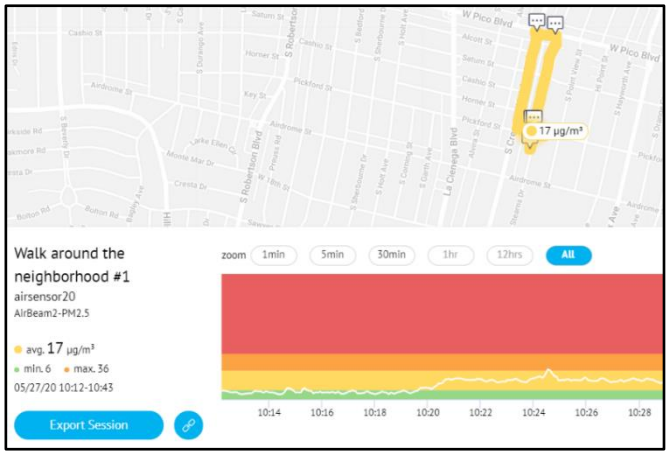
The recent emergence of smaller, portable, low-cost air quality sensors in the marketplace has provided new opportunities for the public to measure air quality. To assist local and state air quality managers, community groups, researchers and others, EPA ORD, in collaboration with EPA Region 9 (Pacific Southwest) and the South Coast Air Quality Management District's (SCAQMD) Air Quality Sensor Performance Evaluation Center (AQ- SPEC), deployed custom-built sensor devices (pods). Research collaborators are evaluating the performance of the pods under "real-world" conditions to measure fine particulate matter ($PM_{2.5}$), ozone (O_3) relative humidity, and temperature at nine locations throughout southern California. The measurements were taken from January 2017 to April 2017. The goal of this project was to characterize the performance of these newly developed Citizen Science Air Monitor (CSAM) pods and better understand their potential applications for community monitoring.

From October 2016 to April 2017, tests were conducted in the laboratory and field (Long Beach, Jurupa Valley, and Coachella Valley) to examine pod performance and operation in real-world conditions. EPA designed and developed the pods and provided guidance on the overall quality assurance and control of the project. AQ-SPEC designed, developed and conducted the field and laboratory testing evaluations of the pods, the field deployment, data collection, data quality assurance and control, and data analysis.

Results from the project provide critical knowledge on pod performance in real-world conditions and sensor data quality, and benefit the development, distribution and access to air quality monitoring technologies for communities. The project also provided a better understanding of how ozone and $PM_{2.5}$ concentrations vary in southern California.

Read the final report titled *Spatial and Temporal Trends in Air Pollutants in the South Coast Basin Using Low Cost Sensors.*

Partner: Los Angeles Public Library (LAPL)
Challenge: Increasing community awareness of air quality and making air sensor technologies and educational resources more accessible
Resource: LAPL Air Sensor Loan Program
Project Period: 2019 – 2020



"Serving the largest city in a state threatened by more and more intense wildfires, Los Angeles Public Library is grateful for this important partnership with EPA. This critical and timely collaboration not only empowered our librarians with the knowledge needed to develop effective air quality educational programs, but also provided the library system with lower-cost air sensor loaning kits for patrons to check out for free. By combining information learned at library programs with firsthand experience of monitoring and interpreting air quality in and outside of their homes, Angelenos will be able to make informed decisions for their health and well-being." – Los Angeles Public Library Neighborhood Science Program Lead Vivienne Byrd

Air quality in the Los Angeles area has improved over the last four decades, but the area still struggles with air pollution, such as fine particulate matter ($PM_{2.5}$) which contributes to asthma, cardiovascular disease, and other health problems. $PM_{2.5}$, along with other air pollutants, is measured at a limited number of regulatory monitoring stations to determine air quality for the area. Communities have become interested in using new, lower-cost air sensors to measure air quality conditions at the neighborhood or street level.

From April 2019 to July 2020, EPA ORD, in collaboration with EPA Region 9 (Pacific Southwest) and the Los Angeles Public Library (LAPL), developed an air sensor loan program. In addition to books, library patrons can check out an air sensor device for free. As part of the program, EPA provided AirBeam2 sensor devices, which measure $PM_{2.5}$, and developed a number of educational resources. The resources included three hands-on lesson plans for exploring outdoor air quality, indoor air quality, and personal air pollution exposure with the public in classroom, group, and one-on-one settings. EPA also provided training to the librarians on the lesson plans and the use of the air sensors.

The LAPL air sensor loan program provides a unique opportunity for the public to access new, lower-cost sensor technologies for free while also learning about both air quality and the actions they can take to protect their health and the environment. Librarians will host workshops and classes using the resources developed to help participants use the air sensors and understand the data collected. The LAPL air sensor loan program concept will be expanded in 2021 in collaboration with EPA Region 5 (Upper Midwest) and EPA Region 10 (Pacific Northwest). Those programs will focus on tribal and rural communities.

To access resources from the LAPL air sensor loan program as well as other educational resources related to air sensors, visit EPA's Air Sensor Toolbox.

Partners: Kansas Department of Health and Environment, Unified Government of Wyandotte County (KS), Wyandotte County Area Business, Mid-America Regional Council, and Argentine, Turner & Amourdale neighborhood representatives
Challenge: Increasing community awareness of air quality and making air sensor technologies more accessible
Resource: AirMapper portable air sensor device
Project Period: 2017 – 2019

"The tools and resources that EPA provided helped educate these Kansas City communities about air quality and helped KDHE respond to this community's concerns." – Kansas Department of Health and Environment Deputy Secretary and Director of Environment Leo Henning

The residential neighborhoods of Turner, Argentine and Amourdale in southeast Kansas City, KS, are impacted by a mixture of emission sources including railyard operations, major highways and other roadways, and light industrial and commercial facilities. Local community concerns about the air quality, with particular attention to a large railroad operation adjacent to the residential neighborhoods, led to a number of research studies in the area to better understand the local air quality.

From October 2017–2018, EPA ORD, in collaboration with EPA Region 7 (Midwest) and EPA's Office of Transportation and Air Quality, conducted the Kansas City Transportation and Local-Scale Air Quality Study (KC-TRAQS) to gain information on the spatial and temporal variability of local air pollution in the impacted neighborhoods. As part of KC-TRAQS, EPA provided portable, battery-powered AirMapper sensor devices to community members and schools for citizen science activities, educational outreach, and air quality awareness. The AirMapper measures particulate matter, carbon dioxide, temperature, humidity, outdoor noise levels, and GPS location in real-time. AirMapper data can be downloaded and viewed on EPA's Real-Time Geospatial Data Reviewer (RETIGO), which is a free web-based tool that allows users to explore and map measurements.

The AirMapper provided an opportunity for community members in southeast Kansas City to access lower-cost sensor technologies for free while also learning about local air quality and engaging in citizen science. Completed in 2019, the project found that air quality in the neighborhoods was well within EPA's national ambient air quality standards.

EPA published instructions that allow anyone to build, operate and maintain an AirMapper device to collect air quality measurements. Access more information on the AirMapper, including accompanying lesson plans for classroom instruction.

Partner: Louisville Metro Air Pollution Control District (LMAPCD)
Challenge: Need for a sensor system that can detect unpleasant smelling air toxics
Resource: Technology development and field implementation of novel air monitoring instrument
Project Period: 2018 – 2020

"The Louisville Metro Air Pollution Control District is currently working on a collaborative project with EPA using novel measurement technology – the oVET – to "sniff" and sample when elevated volatile organic compounds (VOCs) are detected. Investigating objectionable odors from VOCs in a complex airshed with multiple industrial sources is challenging. With nearby residences, being able to quickly identify and quantify VOCs would be a tremendous aid in odor complaint investigations." – Louisville Metro Air Pollution Control District, Interim Director Rachael Hamilton

The Rubbertown area in west Louisville, Kentucky, like many other urban areas, is challenged with significant air quality issues arising from the fugitive volatile organic compound (VOC) emissions released by multiple local industrial pollution sources. The VOC emissions released from these industrial facilities, including over 10 chemical facilities and a municipal wastewater treatment facility, have been contributing to elevated levels of air toxic and malodorous, or bad smelling, VOC compounds that can cause negative health effects on the nearby Rubbertown communities. Fugitive odorous emissions are highly variable in nature and are, therefore, particularly challenging to detect, yet they give rise to odor concerns and cause stress in affected communities.

EPA ORD researchers collaborated with the Louisville Metro Air Pollution Control District (LMAPCD) and EPA Region 4 (Southeast) to develop and demonstrate an innovative VOC sensor system to measure odor causing air toxic VOCs that are suspected of contributing to odor issues in the Rubbertown area. The new measurement technology—called an odor VOC Emissions Tracker (oVET)—was constructed and deployed by EPA ORD in Rubbertown in 2018-2020 with the support of LMAPCD and EPA Region 4. It combines several next-generation measurement approaches to detect and quantify fugitive odorous emissions near industrial facilities.

The project team conducted a field demonstration of the technology in Rubbertown to evaluate its ability to detect the source of odors in the ambient air. The oVET generated ambient measurements of odor causing air toxics coupled with real-time VOC sensor and wind readings. The measurements produced during the field effort are currently under review, and preliminary findings have been communicated to a wider audience in scientific meetings. The final results from this work are expected to provide the community and LMAPCD with actionable information on pollution sources contributing to odor issues in Rubbertown that can help to mitigate future odorous air toxic emissions.

Partners: Michigan Department of Environment, Great Lakes and Energy (EGLE); University of Illinois at Urbana-Champaign
Challenge: Inaccurate methods for quantifying landfill air emissions
Resource: Evaluating next generation emission measurement (NGEM) technologies as an alternative to current methods
Project Period: 2019 – Present

"Helping states understand the accuracy of new and innovative ways to monitor air emissions from landfills will help EGLE be able to better manage air quality in Michigan." – Michigan EGLE Air Quality Division, Assistant Director Jay Olaguer

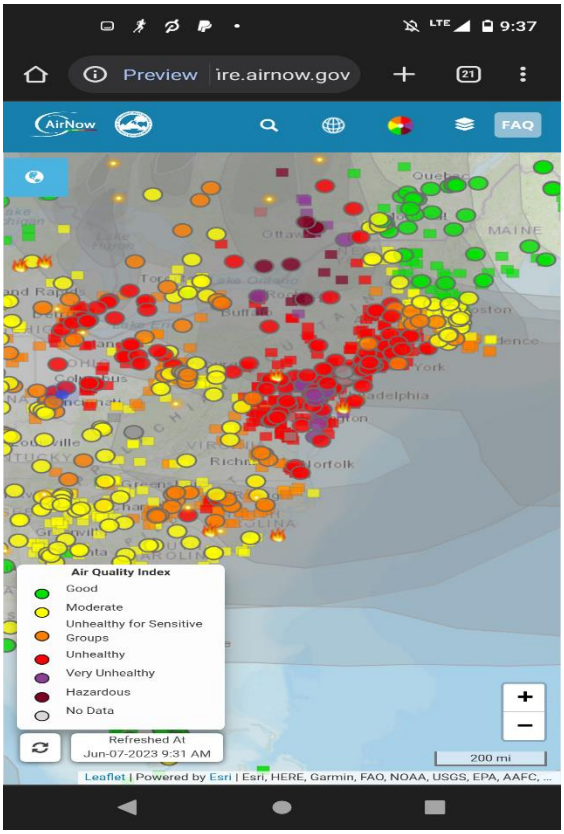
In 2019, EPA reported that over 292 million tons of municipal solid waste (MSW) was generated, with over 50% ending up in landfills. As waste in landfills decomposes, it produces emissions, including methane, nonmethane organic compounds, and hazardous air pollutants. Landfill operators are required to install air emissions control, but many of current approaches are out of date and can be highly inaccurate.

EPA ORD researchers are evaluating next generation emission measurement (NGEM) technologies for quantifying methane and other air emissions from MSW landfills. Initial testing was conducted in October 2019, using a sensor-equipped aerial drone to quantify fugitive methane emissions at a landfill site in EPA Region 5 (serving IL, IN, MI, MN, OH, WI and 35 tribes). EPA researchers then met with partners from the California Air Resources Board, who have been making progress in evaluating NGEM technologies, as well as with technology developers and vendors to help design field work that would benefit Region 5. Working with the measurement team in EPA's Office of Air and Radiation, EPA researchers will collect data on alternative technologies to assist in determining whether the NGEM methods can be substituted for the current EPA-approved method for measuring volatile organic compound (VOC) leaks (Method 21). In collaboration with Michigan EGLE, EPA researchers will identify a landfill site to test different emission-monitoring technologies for comparison.

An EPA report will document the potential benefits of NGEM for identifying and mitigating landfill leaks. Results will help states, regions, and companies estimate fugitive landfill emissions and target actions, such as fixing landfill covers and/or maintenance to gas collection system. With many state and local governments and EPA regions trying to address odor complaints from landfills, this could also provide a quicker monitoring tool to identify potential sources of odors.

AIR – WILDFIRES AND PRESCRIBED BURNS

Partner: Northeast and Mid-Atlantic states, tribes and localities impacted by Canadian wildfires
Challenge: Accessing air quality information during a cross-border wildfire crisis
Resource: AirNow Fire and Smoke Map, in collaboration with the U.S. Forest Service
Project Period: 2023



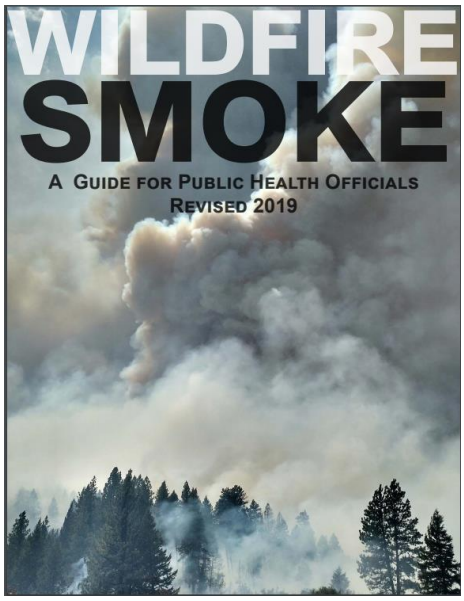
"With wildfire smoke having visible impacts in New Jersey and along the East Coast this year, ORD's work to make air quality and smoke data readily available through AirNow and the AirNow Fire and Smoke Map has been very valuable." – New Jersey Department of Environmental Protection Commissioner Shawn LaTourette

"This past summer, as much of the US has been impacted by the Canadian wildfire smoke, the EPA AirNow Fire and Smoke Map has been an invaluable tool for the New Jersey Department of Health. Such tools are instrumental in providing the agency with situational awareness about environmental conditions across the state that can affect health, which helps guide the development of timely and accurate public health messaging." – New Jersey Department of Health Acting Commissioner Dr. Kaitlan Baston

In June 2023, a large number of active wildfires in Canada, combined with southward wind transport patterns, resulted in smoke and haze blanketing the eastern and midwestern United States. During this time, the added data from air sensors in the AirNow Fire and Smoke Map proved vital for users nationwide. This added data was made possible by an earlier collaborative effort between EPA ORD scientists and staff in EPA's Office of Air Quality, Planning and Standards and the U.S. Forest Service. They developed a national calibration equation supporting the inclusion of PurpleAir sensor data in the Fire and Smoke Map, greatly enhancing the map's usefulness to state, tribal and local agencies. The publicly available, crowdsourced PurpleAir data provides supplemental air quality information in areas between regulatory monitors. With the growing wildfire crisis leading to increased exposures to smoke, state and local air quality agencies need more refined air quality data to effectively prepare and respond to smoke events. The growth of public data from air sensors has helped address this need.

The AirNow Fire and Smoke Map is one of the most accessed air quality tools for states and tribes as they work to prepare for and respond to wildfire smoke. On June 7, 2023, the AirNow Fire and Smoke Map received more than 1.3 million page views – nearly three times the previous high of roughly 0.48 million in August 2021.

Partners: Arkansas Division of Environmental Quality (ADEQ) and the Arkansas Forestry Commission
Challenge: Ambient air quality and public health considerations from fires
Resource: EPA's Smoke Ready Toolbox for Wildfires
Project Period: 2018



"Through this forum Arkansas has advanced partnerships for natural resource management to further the protection of human health and the environment. EPA wildfire and air quality research has helped Arkansas spark collaboration and dialogue among those who benefit from, practice, and live on the periphery of prescribed burns." – Arkansas Department of Energy and Environment, Cabinet Secretary Becky Keogh

Land managers utilize fire in a variety of contexts including forestry, conservation, and agriculture. While Arkansas is attaining and maintaining all national air quality standards, smoke from fires still contains air contaminants that affect air quality. Due largely to the growing urban/rural interface, the interaction between prescribed fire smoke and citizens has increased over time. Facilitating healthy air quality requires ongoing collaboration among land managers and air quality experts.

In March 2018, ADEQ and the Arkansas Forestry Commission jointly hosted a two-day Fire Policy Forum in Little Rock. The Fire Policy Forum was the first of its type in Arkansas and included attendees and speakers from across the country. The forum brought together a diversity of stakeholders, including land owners and managers from federal, state, local, and private sectors, for discussions regarding the intersection of careful and prudent use of "fire as a land management tool," air quality considerations, and solutions to the challenges of balancing these two necessities.

An EPA ORD expert participated in the forum to share EPA wildland fire research on the public health implications of wildfire smoke. The featured presentation informed the Forum's participants of the implications of the growing urban/rural interface and the nearby use of prescribed fire tool. EPA researchers collaborate with communities to facilitate the use of a variety of agency developed resources to prepare and respond to fires, including the Community Health Vulnerability Index, Smoke Sense app, and *Wildfire Smoke: A Guide for Public Health Officials*. These resources are available on the Smoke-Ready Toolbox for Wildfires webpage.

The variety of presentations provided an opportunity for forum participants to discuss air quality as a factor to be considered when conducting activities that cause air contaminant emissions and how to incorporate best management practices and plans for use of fire as a management tool. It also fostered a vibrant dialogue surrounding the use of fire as a land management tool and its effect on air quality in the state of Arkansas.

For more information, please visit the ADEQ Fire Forum webpage.

Partner: Placer County Air Pollution Control District in Auburn, California
Challenge: Provide timely information to the public about air quality conditions and how to reduce exposure to smoke during wildfires
Resource: Smoke Sense App
Project Period: 2018

"Like the Wildfire Smoke: A Guide for Public Health Officials *publication, the* Smoke Sense App *is a valuable tool that resulted from state and federal collaborations. This innovative citizen science mobile application not only provides key information to the public, but also helps public health officials to learn directly from citizens about health impacts of wildfire smoke and actions people are taking to avoid smoke, all of critical importance in California."* – California Department of Public Health, Deputy Director for Environmental Health Mark Starr, PhD

"With mobile devices being more and more for information, having the Smoke Sense App available from the District's webpage provided the public with another valuable resource on air quality conditions in the area along with steps one can take to reduce exposure." – Placer County Air Pollution Control District Associate Planner Ann Hobbs

Over the past 30 years, an average of five million acres of wildlands have burned annually, with the average doubling in recent years. While fire is vital in maintaining ecosystems, there are tradeoffs with its use. Larger and more intense wildfires generate smoke that poses direct risks to human health. Exposure to smoke from fires can cause eye and throat irritation with more serious health problems for children, older adults, and those with existing heart and lung disease.

During the 2018 wildfire season, the Placer County Air Pollution Control District in Auburn, California, shared the Smoke Sense app with their residents as another resource to help them understand the impacts of wildfire smoke in their area and to learn ways to reduce smoke exposures to protect their health.

The Smoke Sense app is part of a study to better understand the impacts of wildland fire smoke on individuals, which includes both controlled and uncontrolled burns; the actions that people take to avoid smoke exposure; and perceptions on health risk communication strategies to encourage people to protect their health during wildfires. EPA has collaborated with states, tribes, counties, public health organizations and others to promote the app as a way to increase awareness of the connection between wildland fire smoke and health.

The Placer County provided a link to the Smoke Sense app along with other public health materials on smoke and wildfires on their website, the California Smoke Blog and social media. Working closely with state, federal and local partners, EPA has created several tools, including the Smoke Sense app, that can be used to help communities prepare and respond to wildland fire smoke.

The Smoke Sense application and other resources on smoke and health are available on the Smoke-Ready Toolbox for Wildfires webpage.

Partner: Kansas Department of Health and Environment (KDHE)
Challenge: Understanding trade-offs associated with prairie rangeland burning
Resource: Multi-model framework and decision support tool in support of Kansas Flint Hills Smoke Management
Project Period: 2018 – Present

"Kansas Department of Health and Environment is excited and optimistic about the potential uses of this multi-model framework, including predicted spatial and temporal patterns of surface fuel loads, live biomass (forage), and soil moisture information that can be used to supplement our existing Flint Hills Smoke Management Plan modeling tool." – KDHE Division of Environment former Director John Mitchell

The Flint Hills ecoregion of eastern Kansas and northern Oklahoma is home to the largest (10,000 square miles) remaining contiguous natural grassland prairie in the U.S. Throughout the region, land managers frequently use controlled burns to sustain the natural prairie ecosystem from the encroachment of eastern Red Cedar and other woody species, and to enhance the quantity and quality of the grasses for cattle grazing. However, smoke from widespread prescribed spring burning can under certain conditions exceed air quality limits and impacted urban areas such as Kansas City, Topeka and Wichita.

To assist rangeland managers and local and state officials in better understanding the economic, ecological and human health trade-offs of rangeland burning in Flint Hills, EPA Region 7 (Midwest) and ORD are collaborating with KDHE to establish a user-friendly, multi-model framework for visualizing historical and hypothetical burning scenarios, including changes in the location, timing and frequency of rangeland burning practices. Part of this effort involves characterizing the emissions from the Flint Hills prescribed burning in both the spring and fall seasons. ORD has conducted aerial sampling with an instrumented, tethered aerostat as well as ground sampling to derive emission factors that characterize the amount and nature of the smoke. Tangible products of the research include computer-generated spatial and temporal maps of predicted changes in rangeland productivity and air quality. Stakeholders and decision makers can use these resources to identify best case scenarios for land management that strike a balance between the environmental, economic, and human health objectives of rural and urban communities.

Partners: Missoula City-County Health Department (MCCHD, MT) and Hoopa Valley Tribe (CA)
Challenge: Reducing indoor air exposures to wildfire smoke
Resource: *Planning Framework for Protecting Commercial Building Occupants from Smoke during Wildfire Events*, in collaboration with the National Institute of Standards and Technology (NIST) and ASHRAE (formerly the American Society of Heating, Refrigerating and Air Conditioning Engineers)
Project Period: 2019 – Present


Goat Creek Fire, MT July 2017

"I'm SUPER excited for the ASHRAE document! Locally, we've found large, commercial spaces to be generally underprepared for wildfire smoke; the ASHRAE framework provides the foundation and expertise we need to address this gap in smoke-readiness. We are currently plotting how we can locally encourage HVAC technicians and building operators to engage with the material to help our community become better prepared for smoke events. It felt like Christmas when it came out!" – Missoula-City County Health Department, Air Quality Specialist Sarah Coefield

EPA ORD is working with local and tribal partners on a solutions-driven research effort to address reducing indoor air exposures to wildfire smoke. One of the concerns raised by partners in Missoula, Montana, was that they had no guidance to use when they talked with building owners about how to improve indoor air quality during wildfire smoke events.

ASHRAE is the organization that develops standards and guidance for the built environment, including ventilation and other practices affecting indoor air quality. Inspired by the need identified by Missoula partners, EPA ORD scientists began conversations with NIST about working with ASHRAE to address wildfire smoke. Early in 2020, a proposal developed jointly by EPA and NIST was approved. By summer 2020, ASHRAE formed a committee to develop a guideline, *Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events.* Several scientists from EPA and NIST are participating on the committee, along with representatives from industry and other government agencies. ASHRAE expects the Guideline will be completed in 2022.

Given the urgency of providing initial guidance before the next wildfire season, ASHRAE asked the new committee to work quickly to develop an interim document. The result was the publication of the short ASHRAE document—Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Events—in February 2021.

This is the first document to provide information to help owners and managers of commercial buildings, including schools, prepare for smoke related to wildfires or prescribed burning so that they can protect the health of people in their buildings. Additional information is available on EPA's Wildfires and Indoor Air Quality in Schools and Commercial Buildings webpage.

Partners: Washington State Department of Health, North Carolina Department of Health and Human Services Division of Public Health and others
Challenge: Improving access to health risk communication among limited English proficiency populations
Resource: Smoke Sense mobile app with text translated into Spanish
Project Period: 2017 – Present

"There is an urgent need to address research gaps and to prioritize practical solutions that can reduce smoke-related adverse health effects among agricultural workers. A large portion of the Pacific Northwest agricultural workforce is Spanish-speaking and at disproportionate risk of adverse occupational health effects from poor air quality during wildfire events. Growers have used the Smoke Sense app as part of their decision support to help reduce this exposure." – University of Washington School of Public Health, Pacific Northwest Agricultural Safety and Health Center, Outreach Director Edward Kasner PhD, MPH

Exposure to wildfire smoke is a community health issue that has been gaining the attention of public health professionals and organizations, especially in states where fires are frequently large and intense. Wildfire smoke has significant health implications for those near the fire, as well as for those living farther downwind. While these risks affect the population broadly, individuals with limited English proficiency are at increased risk of exposure due to limited access to health risk communication resources that provide clear information about wildfire smoke and the exposure reduction actions they can take.

The Smoke Sense citizen science project aims to increase awareness about the health risks associated with inhalation of wildfire smoke and actions individuals can take to reduce the amount of smoke they breathe. The Smoke Sense mobile app is free to download, available on both iOS and Android phones, and has more than 44,000 participants. Through feedback from stakeholders, the Smoke Sense team learned that translating text in the app into Spanish would reduce a barrier for receiving information among individuals who speak Spanish and have limited English proficiency. Based on this feedback, the research team adapted the app's source code to accept translated text. The first language the app has been translated into is Spanish, allowing Spanish-speaking individuals to engage more fully. This effort reduces barriers for individuals with limited English proficiency by making available within the Smoke Sense app information about evolving environmental health threats and protective health behaviors.

Partners: State & local environmental and health agencies (AK, AZ, CA, CO, ID, MT, ND, NM, NV, OR, SD, UT, WA, WY), regional clean air agencies, Western States Air Resources Council and interested tribes
Challenge: Addressing state, regional & local and tribal research needs related to wildland fires
Resource: EPA-hosted listening sessions with state & local agencies from western and neighboring states and tribal representatives to discuss their research priorities and needs concerning wildland fires
Project Period: January – February 2022

"This convening was so important for highlighting our science needs to EPA on life and death wildfire issues, and to share knowledge among state colleagues facing the same challenges." – Oregon Health Authority, Environmental Public Health Section Manager Gabriela Goldfarb

"What I took away from listening to other Tribes was the frustration at not being allowed to burn in their traditional manner, and that there appears to be a disconnect between EPA's interest in smoke/air quality and Tribal interests in effects of fire on water and ecology and groundwater (used for drinking). I hope that listening to Tribal interests guides upcoming research. It was useful to know that mobile monitoring systems are being developed, and I hope Tribes are involved to ensure new systems fit their needs." – Chickaloon Native Village (Alaska) Environmental Program Manager Kendra Zamzow, PhD

Increasing fire activity has had significant impacts on the western states as well as tribes. As EPA continues efforts to address the challenging questions associated with wildland fires and their impacts, it is imperative to ensure that we understand the greatest concerns of our partners in the states, tribes and regions.

EPA ORD invited representatives from 14 western and neighboring state, regional & local environmental and health agencies, as well as tribal nations to participate in a series of listening sessions held in January and February 2021. State, regional & local agencies and tribes shared their top challenges and science needs related to wildland fires (including wildfires and prescribed burning) and smoke. Their input is of critical importance as we work together to better understand the impacts of wildland fires more fully on air quality, water quality and health, as well as how best to communicate to the public.

These localized perspectives, comments and feedback from the listening sessions were captured by EPA staff and will be used to inform ORD's implementation of its wildland fire research program and development of ORD's 2023-2026 Strategic Research Action Plans.

The listening sessions were also an opportunity to provide attendees with overviews of current EPA research on wildland fires and key resources available to support states, tribes and communities. For more information, visit AirNow Fire and Smoke Map Pilot Project, Smoke Sense, Smoke Ready Toolbox for Wildfires, and Wildfire Smoke Guide. EPA ORD held follow-up webinars in early 2022 to summarize what we heard from these listening sessions, what we are currently doing to address the needs and challenges expressed by states, tribes and local agencies, and how we expect to incorporate additional considerations in our Fiscal Year 2023-2026 research planning.

Partner: State, local and tribal air organizations
Challenge: In many areas affected by wildfire smoke, air monitoring data may be limited or absent
Resource: EPA is loaning air monitoring technologies to help organizations assess smoke impacts and provide public health information with timely data
Project Period: September 2021 – Present

"Before WSMART, we only had monitoring for ozone near our area. Because of this, we would look on AIRNow, and it said our air quality was good though we were able to see smoke in the air. In 2022, we received four PM2.5 sensors from WSMART which gave us real-time data in our area and helped us distribute accurate information about smoke impacts to the tribal community." – Fallon Pauite-Shoshone Tribe's Environmental Protection Department Environmental Specialist Sonia Corleto

The growing threat of wildfires and related smoke impacts is a public health concern in the United States. In many areas affected by wildfire smoke, air monitoring data may be limited or absent. Supplemental measurement technologies can help air monitoring organizations gather timely data to assess smoke impacts and provide public health information.

To increase supplemental air monitoring data during wildfires, EPA ORD launched the Wildfire Smoke Air Monitoring Response Technology (WSMART) Pilot in September 2021. WSMART has made specific air monitoring technologies available for loan to state, local and tribal air organizations. The current systems available upon request are two stationary sampling air sensor systems and a portable system called the Vehicle Add-On Mobile Monitoring System (VAMMS).

EPA loans the air measurement devices directly to state, local and tribal air organizations to support supplemental air monitoring in areas affected by wildfire smoke and with observational data coverage gaps. EPA also loans monitors to the Interagency Wildland Fire Air Quality Response Program for use by Air Resource Advisors (ARAs) who work with Incident Management Teams at major wildfires. ARAs coordinate with state, local and tribal organizations to share information regarding wildfire smoke conditions and coordinate public messaging. The WSMART program has and continues to support air quality government organizations at the frontline of wildfire smoke response become better equipped to assess smoke conditions and protect public health during wildfires.

Eligible organizations can make requests for air monitoring equipment through the WSMART Pilot page.

CHEMICALS - ASBESTOS

Partner: Montana Department of Environmental Quality (DEQ)
Challenge: Asbestos exposure following forest fires
Resource: Computer modeling in collaboration with the U.S. Forest Service
Project Period: 2012 – 2016

"The modeling results were used to scope and plan for the potential socio-political and management challenges resulting from a wildfire occurring in or threatening a portion of the Libby Asbestos Superfund Site. These results will also be used to assist the Montana DEQ in evaluating proposed remedies, and [they] are important in informing local and Montana Department of Natural Resources and Conservation firefighters in developing response actions to protect firefighters and the citizens of Libby and the surrounding area." – Montana DEQ, Remediation Division Project Manager Lisa Dewitt

As noted above, Libby amphibole asbestos (LAA) has been found to co-occur with the vermiculite ore that was mined in Libby, Montana starting in the 1920s. Due to the presence of asbestos, additional concerns have been raised about the potential for forest fires near the Libby Asbestos site to spread asbestos fibers, exposing firefighters and those living adjacent to the Libby site.

To address this potential health hazard, EPA ORD, in collaboration with EPA Region 8 (Mountains and Plains), provided technical support to Montana DEQ in assessing the health risks associated with potential forest fires near the Libby Asbestos site in Montana. Specifically, ORD conducted experiments to understand the potential asbestos emissions, and EPA Region 8 used these data in a model to assess whether these emissions would result in potential exposures. To obtain emissions data, ORD first burned forest floor material from a portion of the Libby Asbestos site, simulating a forest fire. During these simulated burns, particulate matter and gaseous emissions were measured and samples of the ash were analyzed to determine whether these samples contained asbestos. These data suggested that only a small fraction of the asbestos in the forest floor material was released into the gas phase.

EPA Region 8 then used these data, along with direct measurements of asbestos in the forest floor at the Libby site, and estimated combustion and meteorological conditions in a model to estimate potential asbestos exposures under various scenarios. Because of these modeling efforts, EPA was then able to provide Montana DEQ with the range of potential exposures for these scenarios. In addition, EPA is now able to model forest fires when they do occur to more accurately estimate exposures and health risks to firefighters and to the surrounding communities.

Read the synthesis report titled *Emissions of Amphibole Asbestos from the Simulated Open Burning of Duff from Libby, Montana.*

Partner: Montana Department of Environmental Quality (DEQ)
Challenge: Addressing human health risks of exposure to Libby amphibole asbestos
Resource: Integrated Risk Information System (IRIS) assessment
Project Period: 2009 – 2019

"EPA ORD establishing the toxicity of the Libby amphibole asbestos (LAA) was key to completing the multipathway risk analysis that was necessary for the remedial action to move forward and provide confidence for the public that a decade of EPA removal actions was protective." – Montana DEQ, Remediation Division Project Manager Lisa Dewitt

Libby amphibole asbestos (LAA) has been found to co-occur with the vermiculite ore that was mined in Libby, Montana starting in the 1920s. When the mining and milling operations were active, residents of the Libby region were exposed to high air concentrations of LAA. Local clinics began to observe incidences of respiratory disease in the Libby area that were much higher than the national average for these asbestos-related diseases. After mining and milling operations ceased, exposures still occurred from soils and vermiculite home insulation contaminated with LAA; from roads, driveways and recreational areas where mine tailings containing LAA had been used; and from former vermiculite processing facilities located in Libby. In 2002, the Libby mining and milling operations site (Libby Asbestos) was placed on the Superfund National Priorities List.

The community had great concerns about the risks posed by the asbestos contamination in the town, with a significant portion of residents concerned that the particular kind of asbestos in Libby was more toxic than other forms of asbestos. In 2009, EPA announced that a public health emergency existed at the Libby asbestos site – this was the first time EPA had made a determination under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that conditions at a site constituted a public health emergency.

EPA ORD, in collaboration with Region 8 (Mountains and Plains), developed an Integrated Risk Information System (IRIS) assessment of the asbestos mixture found in Libby (referred to as Libby amphibole asbestos). Based on epidemiological analyses of workers exposed to LAA, the assessment concluded that inhalation exposure to LAA could lead to thickening of the membranes that envelop the lungs, which could decrease lung function. The assessment was able to identify a level of exposure that, over a lifetime, would be unlikely to cause such effects on the lung membranes. This was the first quantitative toxicity estimate of adverse non- cancer health effects for any type of asbestos. The assessment also established that the asbestos found in Libby produced cancer, and importantly for the community, was able to show it was similar in potency to other forms of asbestos.

With the IRIS assessment of LAA, along with site-specific exposure data, decisions could be made to protect human health and to address community concerns about the toxicity of the specific form of asbestos found in their area. EPA's Libby Superfund Site Human Health Risk Assessment, using the IRIS assessment, showed that the cleanup actions EPA has taken since 1999 have reduced LAA exposures and risks at the Libby Asbestos site. The asbestos ambient air concentrations there today are about 100,000 times lower than when mine and processing facilities were in operation, making today's air quality in Libby similar to other Montana cities. In April of 2019, EPA and the Montana Department of Environmental Quality were able to remove part of the site from the NPL, due in part to having the IRIS assessment values.

CHEMICALS – ASSESSMENTS

Partner: Interstate Technology & Regulatory Council (ITRC)
Challenge: Need for improved understanding of the current science regarding microplastics
Resources: Microplastics Online Guidance Document, web-based training, and outreach toolkit for risk communication
Project Period: 2021 – 2024

"The Microplastics Toolkit will provide materials that can be used to help explain microplastics to diverse audiences, from upper management to the general public. The toolkit will also provide resources regarding effective outreach strategies." – California DTSC Valerie Hanley (ITRC Microplastics Team Co-Lead)

Microplastics are tiny plastic pieces less than 5 millimeters in size which can be found in various sources. Microplastics can be categorized as primary (intentionally added or fit for use), such as in cosmetics and fertilizer pellets, or secondary (produced through the breakdown of larger macroplastics), such as from plastic packaging and fibers shed from clothing. Microplastics have been introduced to the environment over the last 50 years through their use in consumer products and industrial practices, as well as through plastic refuse, which has been broken down and entered the waste stream. Exposure to microplastics has the potential to harm wildlife, ecosystems, and human health by accumulating in the environment and entering the food chain.

The ITRC Microplastics Team was formed in 2021 and published its first resource in February 2023, an online Microplastics Guidance Document that provides readers with information on microplastics and the state of the applied science. EPA scientists participate on the team, providing their technical expertise, collaborating through discussions and meetings, and by providing written comments on draft ITRC materials. Written with the state regulator in mind, the technical guidance is also a useful tool for industry members and decision makers, covering topics such as sources and impacts of microplastics, environmental fate and transport, sampling and analysis, best practices for prevention and mitigation, and current policies and regulations. The team is currently developing an outreach toolkit to provide resources for environmental professionals to use in communicating microplastic issues to members of the public.

The Microplastics team held its first web-based training in March 2023, which uses a conceptual site model to navigate microplastics in the environment and explore areas covered in the Guidance Document. Additional live training will be provided in late 2023 and in 2024.

Partner: Interstate Technology and Regulatory Council (ITRC)
Challenge: Addressing contaminants of emerging concern (CEC)
Resource: ITRC team collaborating on guidance for States in addressing CEC
Project Period: 2021 – Present

"The ITRC CEC Team is grateful to USEPA for its involvement in developing and reviewing its draft work products. This involvement will hopefully facilitate use of the ITRC CEC Guidance by the States and be conducive to informing a technically defensible and effective approach to evaluating CEC." – ITRC CEC Team Leaders Paula Panzino, AZ DEQ, and Vivek Mathrani, CA DTSC

Many states, territories and localities struggle with the challenge of addressing contaminants of emerging concern (CEC). According to the Interstate Regulatory and Technology Council, CEC refer to "substances and microorganisms including physical, chemical, biological, or radiological materials known or anticipated to be present in the environment, that may pose newly identified risks to human health or the environment." When CEC are encountered, there is often sparse or outdated information in the hazard, exposure, and fate and transport domains. There is no one given approach to how to handle CEC, and states, territories and localities may find it daunting to develop a monitoring and action-oriented program that can systematically prioritize and deal with them.

Source: Contaminants of Emerging Concern Team, Interstate Technology and Regulatory Council. Used with Permission.

To address this challenge, ITRC assembled a Contaminants of Emerging Concern Team and invited EPA and other scientists to participate. In support of cooperative federalism, EPA scientists and staff engage with ITRC teams to advance the development of resources that can support state and territorial partners in meeting the common mission of protecting human health and the environment. Since 2021, EPA scientists have supported the ITRC CEC team by contributing expertise to support the development of fact sheets that can assist states, territories and localities in accessing resources to address CEC under their jurisdiction. These resources may include approaches on monitoring programs and analytical methods, key information on toxicity, exposure, and fate and transport properties to help prioritize CEC, risk communication tools, and case studies.

It is anticipated that the fact sheets and related training sessions will be useful in the face of challenges associated with CEC.

Partner: Minnesota Department of Health (MDH)
Challenge: Identify and communicate the potential for hazardous chemicals
Resources: Software and computational tools to screen and prioritize chemicals to protect public health.
Project Period: 2019 – Present

"The software developed by EPA to assist our Toxics Free Kids program will be an integral part of our prioritization review process and will provide greater transparency and timeliness as we continue to provide Minnesotans with information about exposure to potentially hazardous chemicals. This software can do in minutes what would have taken us weeks to do manually and MDH is grateful for this partnership." –MDH Research Scientist David Bell

The Minnesota Department of Health (MDH) measures and evaluates the potential health risks of chemical exposures in the environment and in Minnesotans, especially children and pregnant people. EPA ORD and MDH are collaborating on two projects to develop computational tools to advance this work.

Project One: Protecting Minnesota's Children
The first project focuses on developing software which can be used by MN to prioritize chemicals which may pose more of a risk to children, as required by the MN Toxic Free Kids Act. MN's Toxic Free Kids (TFK) program identifies and communicates the potential for hazardous chemical exposures from consumer products to harm human health, particularly to vulnerable or susceptible populations.

To support the program, ORD developed a hazard and exposure comparison software to facilitate rapid and reproducible evaluations of chemicals for their potential risks to children and people who could become pregnant. The Chemical Prioritization software for the TFK program compares the relative hazards of multiple chemicals simultaneously via color coded scoring. In addition, it provides the underlying scoring based on MN's criteria which were used to assign the final scores and provides hyperlinks to more data for chemicals of interest to MDH.
The downloadable software is being used by the MDH TFK program to review and revise the Chemicals of High Concern list every three years and prioritize chemicals for consideration for their Priority Chemical List. The MDH uses these lists to communicate the potential hazard of these chemicals to the public through various communication mechanisms including reports that summarize these lists on their website and through community outreach. It is anticipated other states with similar legislation pertaining to children's health and chemical exposure may be interested in using this application.

Project Two: Screening Water for Chemicals of Concern
The second project focuses on developing an automated chemical exposure workflow for the MN Contaminants of Emerging Concern (CEC) program. MN's CEC program identifies chemicals in water that have no current regulatory standard yet may potentially pose a risk. Nominated chemicals undergo a screening-level evaluation and ranking based on exposure and toxicity potential. The CEC program currently evaluates exposure potential one chemical at a time using a standardized set of sources and procedures. ORD worked with MDH to develop an automated workflow that would enable rapid evaluation of thousands of chemicals using MDH's criteria.

MDH has evaluated the results of the CEC initiative automated workflow using a case study of 1,800 chemicals, including 82 chemicals already evaluated by MDH using its existing manual process. MDH found reasonably good agreement between the manual and automated workflows. This indicates that the automated workflow will be a useful tool to accelerate exposure screening evaluations and expand the number of chemicals assessed, freeing resources to complete the more complex aspects of exposure assessment. In addition, this allows for more efficient re-screening of previously evaluated chemicals to incorporate updated or newly available information. The automated workflow developed by EPA ORD greatly reduces the time and resources needed to identify higher priority water contaminants by eliminating much time-consuming data collection work.

Partner: National Tribal Toxics Council, National Tribal Science Council, Tribal Pesticide Program Council
Challenge: Understanding chemical exposures to Tribes and subsistence populations via seafood consumption
Resource: Conduct a systematic review on subsistence aquatic biota consumption in collaboration with Tribal partners
Project Period: 2019 – present

"Historically we had as much fish as we needed to eat. Now our consumption is suppressed. We would eat more if we had more." – Lower Elwha Klallam Tribe Vice Chairman Russell N. Hepfer

Fishing and seafood consumption play an important role in the health, culture, and way of life for many subsistence populations. subsistence fishing populations include Tribes, fishers, and other populations who obtain most of their nutritional and caloric energy needs from consuming waterborne species (aquatic biota) such as fish and/or shellfish. Under the Toxic Substances Control Act (TSCA), EPA conducts chemical risk evaluations to determine whether a chemical substance presents an unreasonable risk to health or the environment. The 2016 Lautenberg Act amends TSCA and helps EPA further ensure the safety of chemicals while explicitly considering "potentially exposed susceptible subpopulations." Tribes have advocated to have subsistence exposure included in EPA risk assessments and have raised concerns that historically during TSCA reviews, EPA has missed important data on subsistence fish consumption that may have important implications for human health and the environment.

Given the opportunity to address this gap, in 2019 EPA ORD and the Office of Chemical Safety and Pollution Prevention (OCSPP) partnered with the National Tribal Toxics Council, the National Tribal Science Council and the Tribal Pesticide Program Council to conduct a systematic literature review of fish, seafood and other waterborne species. A systematic literature review examines available evidence using explicit and reproducible methods to systematically search, critically appraise, and synthesize information on a specific issue using strategies that reduce biases. EPA ORD researchers, OCSPP staff and Tribal partners, in collaboration with EPA Region 10, formed a workgroup to determine an appropriate systematic review approach. EPA provided training on systematic review processes and tools to help identify relevant references and organize them to facilitate the review of literature. This empowered tribal workgroup members to significantly contribute to the systematic review from the gathering of data to completing the full-text reference screenings.

An upcoming EPA report with results and collected data from this project will inform public health assessments and evaluations such as TSCA chemical evaluations or other human health risk assessments that include estimating exposures to environmental contaminants via consumption of fish or shellfish throughout the U.S.

Partner: Alaska Department of Environmental Conservation (ADEC)
Challenge: Toxicity information for sulfolane to inform cleanup levels
Resource: Peer review of the available reference doses (RfDs) and technical support
Project Period: 2010 – 2014

"EPA's technical experts played a vital part in assisting the state of Alaska in understanding the risks of sulfolane in groundwater and the potential impacts to public health. EPA provided critical information on sulfolane mobility, toxicity and human health exposures that greatly assisted ADEC in making decisions on protecting residents. ADEC appreciates EPA for all their timely support and help by providing information on the best available science which was significant in Alaska's response actions for sulfolane."
– ADEC Division of Spill Prevention and Response, Director Kristin Ryan

Sulfolane is an industrial solvent used in gasoline production and petroleum refining. The discovery in late 2009 of sulfolane in drinking water wells near the Flint Hills North Pole Refinery (about 15 miles east of Fairbanks, AK), led to an extensive investigation of contaminated groundwater. The groundwater plume is approximately 2 miles wide, 3.5 miles long and over 300 feet deep, rendering it one of the largest in the state, with many private properties impacted. The National Toxicology Program (NTP) began new animal studies on sulfolane in 2014.

EPA's Region 10 (Pacific Northwest) requested that ORD develop a Provisional Peer-Reviewed Toxicity Value (PPRTV) assessment for sulfolane. The information in PPRTV assessments can be used in combination with exposure information to characterize the public health risks of a given substance at a particular hazardous waste site. Importantly, these risk characterizations can form the basis for risk-based decision making, regulatory activities, and other risk management decisions designed to characterize and protect public health. EPA ORD finalized the PPRTV assessment in 2012.

At ADEC's request in 2014, EPA ORD scientists participated in an independent, expert peer review workshop to discuss the available oral toxicity values/reference doses for sulfolane (including the PPRTV) and reach conclusions based on the available science. EPA ORD scientists provided essential technical support in the peer review workshop with respect to the scientific development process of the Sulfolane PPRTV assessment. This technical support assisted ADEC in their consideration of cleanup levels for contaminated groundwater.

Ultimately, ADEC decided to wait to set a cleanup level for sulfolane until more data become available from the new NTP studies, in order to best protect people from exposure. EPA ORD's input provided ADEC with important information that will be needed for making a final determination.

Partners: California Environmental Protection Agency's (CalEPA) Department of Toxic Substances Control (DTSC) and Office of Environmental Health Hazard Assessment (OEHHA)
Challenge: Evaluating chemicals for health effects
Resource: New technologies, models, tools, data and other chemical information
Project Period: 2015 – Present

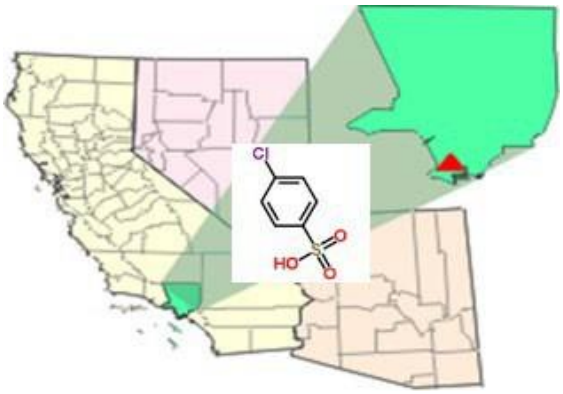
"California benefits significantly from our partnership with EPA ORD. We use ToxCast data to provide valuable insight into how chemicals may cause toxicity, and we use their lifecycle analytic and exposure modeling and monitoring for various state efforts including our work on safer consumer products. EPA ORD resources are helping us to make more informed decisions about the potential health effects of chemicals."
– CalEPA former Secretary Matthew Rodriquez

CalEPA's DTSC and OEHHA are collaborating with EPA ORD to use New Approach Methods (NAMs) developed by our scientists to evaluate the potential health effects of chemicals. Over the past few years, CA DTSC has been using high-throughput screening data generated by EPA ORD to inform chemical risk assessments for certain pesticides. OEHAA has been using high-throughput screening data and exposure information generated by ORD to evaluate chemicals used in consumer products and found in drinking water. is publicly available on the Computational Toxicology (CompTox) Chemicals Dashboard

Specifically, DTSC is using ORD high-throughput chemical data in a Risk Characterization Document which is evaluating the risk to human health resulting from inhalation of the fumigant allyl isothiocyanate (AITC). The risk assessment process for AITC was initiated in 2018 due to its proposed use and based on evidence that it may cause reproductive toxicity, genotoxicity, and oncogenicity in animal studies. The risk assessment document was presented during a public meeting and finalized in April 2022.

In 2020, CalEPA's OEHHA used high-throughput screening (HTS) data from ORD to examine mechanisms of action of synthetic food dyes and included the data in a risk assessment. Using the data, they developed an approach to examining potential mechanisms of these synthetic food dyes. In 2021, OEHHA also used ORD high-throughput data on Perfluorooctanoic Acid (PFOAs) and Perfluorooctane Sulfonic Acid (PFOS) in drinking water. This data is used in the Public Health Goal (PHG) technical support documents which provide information on health effects from contaminants in California drinking water. PHGs published by OEHHA are used to establish primary drinking water standards. OEHHA also used high-throughput screening data to evaluate the potential carcinogenicity of acetaminophen, gentian violet and Perfluorooctane Sulfonic Acid (PFOS). This data is used in a Proposition 65 which requires the publication of a list of chemicals "known to the state" to cause cancer or reproductive toxicity. The Carcinogen Identification Committee (CIC) advises and assists OEHHA and adds chemicals to the Proposition 65 list of chemicals that cause cancer. Since 2015, ORD has worked collaboratively with CalEPA staff to provide suggestions for using data in risk assessments and provide expertise about how to interpret the data. CalEPA staff have participated in EPA hosted trainings, workshops and webinars. This collaboration is helping California and US EPA use scientific advances to make more informed decisions about the potential health effects of chemicals, as well as determine safer and more sustainable uses of chemicals found in consumer products.

Partner: California Environmental Protection Agency (CalEPA)
Challenge: Setting a risk-based cleanup level for para-Chlorobenzene Sulfonic Acid (p-CBSA)
Resource: Provisional Peer-Reviewed Toxicity Value (PPRTV) for p-CBSA
Project Period: 2016



"When a chemical that had not been well-studied threatened an important drinking water aquifer in the L.A. Basin, scientists from ORD were important partners. They worked collaboratively with our state scientists to develop a risk assessment using the best available science." – CalEPA former Secretary Matthew Rodriquez

The potential toxic effects of para-Chlorobenzene Sulfonic Acid (p-CBSA), a by-product of the production of the pesticide dichlorodiphenyltrichloroethane (DDT), present health concerns, particularly for drinking water contamination because the chemical is highly water soluble and mobile in aqueous environments. It has been identified in potential drinking water sources beneath and near sites in California, such as the former Montrose Chemical Corporation where DDT was manufactured from the 1950s to the early 1980s.

Because of high interest in evaluating the potential human health effects of p-CBSA, CalEPA and EPA ORD, in collaboration with Region 9 (Pacific Southwest), worked together in assembling existing study data leading to the development of a Provisional Peer-Reviewed Toxicity Value (PPRTV) assessment for p-CBSA. Importantly, the information in PPRTV assessments can be used in combination with exposure metrics to characterize the public health risks of a given substance at a particular Superfund site. These risk characterizations can form the basis for risk-based decision making, regulatory activities and other risk management decisions designed to characterize and protect human health.

EPA ORD's PPRTV assessment identified information sufficient for derivation of a provisional reference value that informs risk associated with oral p-CBSA exposures. The impact of this work will be realized in the facilitation of risk-based decision making and activities on sites contaminated with p-CBSA.

Partner: California Environmental Protection Agency's (CalEPA) Department of Toxic Substances Control (DTSC)
Challenge: To inform the identification of "Priority Products," California DTSC must understand the potential for exposures to chemicals contained in specific consumer products
Resource: Application of high-throughput human exposure models for thousands of chemical-product combinations
Project Period: 2017 – 2019

"The Safer Consumer Product regulations don't use quantitative risk assessment to prioritize product-chemical combinations as Priority Products. Instead, the regulatory criteria are exposure potential and hazard potential using a narrative standard. So, determining exposure is critical for our decision making. The Stochastic Human Exposure and Dose Simulation High Throughput (SHEDS-HT) model and product intake fraction modeling are valuable tools to help us assess exposure. CA DTSC can use SHEDS-HT to support the selection of Priority Product categories and accelerate our screening of chemicals in our work plan including flame retardants, antimicrobials, per- and polyfluoroalkyl substances (PFAS), and fragrances." – CalEPA DTSC Director Meredith Williams

California DTSC's Safer Consumer Products program uses a multi-step process to reduce toxic chemicals in the products that consumers buy and use. It identifies specific products that contain potentially harmful chemicals and asks manufacturers if the chemical is chemical necessary and if there a safer alternative. DTSC identifies "Candidate Chemicals" which may pose a health hazard, and then identifies "Priority Products" in which they may occur. DTSC would like to consider potential human exposures associated with Candidate Chemicals when deciding which products are a priority. However, since measured exposure data are rarely available for all potential chemicals and products, exposure model predictions are needed.

EPA ORD's High-Throughput Stochastic Human Exposure and Dose Simulation Model (SHEDS-HT) is a population-based model of human exposure to chemicals in consumer products that can be used to meet this need. Inputs to SHEDS-HT include product compositions (i.e., chemical concentrations in various product types), human behavior patterns (e.g., frequency and amount of product use), chemical properties, and population characteristics. ORD has also developed a database of product chemical ingredient data called the Chemicals and Products Database (CPDat) by collecting and summarizing data on thousands of products from publicly- available data sources such as Material Safety Data Sheets and manufacturer ingredient lists. Using CPDat, ORD scientists performed SHEDS-HT simulations of the predicted exposures associated with thousands of chemical-consumer product combinations, including chemicals currently included on the DTSC Candidate Chemical List.

DTSC plans on using the SHEDS-HT results to support selection of Priority Product categories and further prioritization or evaluation of products and chemicals. These activities will directly support California's Safer Consumer Products program stated goal of identifying and prioritizing chemicals in consumer products with the potential to cause adverse impacts on public health and environment.

For more information, visit the SHEDS-HT homepage.

Partners: Louisiana Department of Environmental Quality (LDEQ) and LaPlace, LA
Challenge: Potential cancer risks from emissions of chloroprene
Resource: IRIS assessment and air quality monitoring
Project Period: 2016 – Present

"I want to thank EPA's Office of Research and Development for their assistance in gathering and interpreting air quality data from around the Denka Performance Elastomer facility in LaPlace, LA. The information ORD provided helped the LDEQ design and implement actions to reduce chloroprene emissions from the plant. The multi-step Denka remedy is in the first stages of its implementation and has already produced significant reductions in chloroprene emissions. When agencies work together, everyone benefits." – LDEQ, Secretary Chuck Carr Brown, PhD

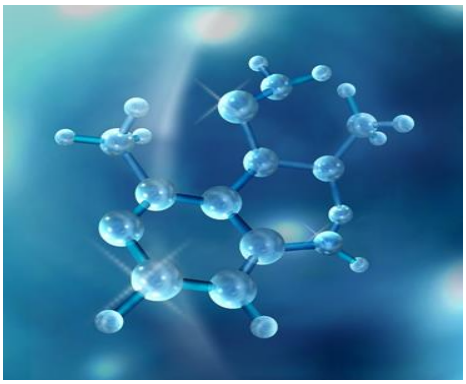
EPA ORD scientists assisted Region 6 (South Central U.S.) and the state of Louisiana with their evaluation of potential cancer risks from emissions of chloroprene from the Denka Performance Elastomer facility in LaPlace. Based on the risk evaluation and an engineering analyses, the company reached an agreement with Louisiana to install control equipment to significantly reduce chloroprene emissions. The facility had been identified in the EPA's National Air Toxics Assessment (December 2015) as the highest cancer risk facility in the U.S., leading to ambient air monitoring in the vicinity of the facility.

The air monitoring demonstrated high levels of chloroprene in the ambient air in the surrounding neighborhood and at schools near the facility. ORD scientists and staff from the LDEQ, EPA's Region 6 and Office of Air and Radiation met with the community at a public meeting in LaPlace. EPA researchers characterized the potential health risks associated with chloroprene.

In March 2020, EPA deployed a network of six SPod air monitors around the Denka facility. These new monitors should provide a better understanding of the frequency and magnitude of chloroprene emission spikes and may identify possible actions to further reduce chloroprene in the community. SPod monitoring results will be posted when they become available. EPA researchers continue to assist Region 6 and the state of Louisiana to achieve action to reduce public health risks from the chloroprene emissions.

Additional information on EPA's work in LaPlace, Louisiana.

Partner: Minnesota Department of Health
Challenge: Tapping data from the latest innovations in toxicology to advance chemical risk assessments **Resource:** Chemical data from read-across, QSAR (quantitative structure–activity relationship) model, high-throughput screening, computer modeling and other new technologies and methods
Project Period: 2018 – Present



"Minnesota has benefited greatly from this collaboration. It's provided us access to top-notch scientists at EPA, and their expertise in chemical screening and evaluation has been really helpful to our work." – Minnesota Department of Health, Environmental Health Division Director Tom Hogan

"Because of this collaboration we have new tools in our hands to help us perform exposure screening faster and more in depth than before. Ultimately we hope the collaboration will also bring us new tools for hazard screening and identifying chemicals of emerging concern that are relevant to Minnesota." – Minnesota Department of Health, Research Scientist Supervisor Sarah Fossen Johnson

EPA and Minnesota Department of Health (MDH) are responsible for protecting public health and the environment from the unintended consequences of exposure to environmental chemicals. EPA ORD researchers are developing New Approach Methods (NAMs) to screen thousands of chemicals and flag those that warrant further investigation. NAMs are particularly important for informing risk assessments of contaminants of emerging concern (CECs). To protect public health, MDH's Health Risk Assessment Unit establishes human health-based risk assessments for CECs for the state's ground and surface water resources.

EPA ORD researchers completed a pilot program in 2019 to develop an automated workflow for exposure screening of drinking water contaminants of concerns. The goal was to incorporate high-throughput (HT) exposure NAMs from ORD's ExpoCast project into MDH's predominantly manual exposure screening process. Results improved both the reproducibility and speed of the exposure screening—reducing single-chemical evaluations from days to mere minutes.

These improvements will allow MDH to screen large comprehensive libraries of chemicals for potential candidates for the state's CEC regulatory program. In addition, the incorporation of new information from ExpoCast, including chemical use descriptors, chemical monitoring information, and HT exposure model predictions have provided expanded screening criteria for data-poor chemicals. ORD is now working directly with MDH to apply hazard based NAMs to the complementary hazard screening stage of the CEC program.

Going forward, EPA ORD researchers will be closely collaborating with MDH to develop more pilot efforts to use NAMs to evaluate health effects of chemicals. Together, they plan to tackle high priority areas such as evaluating health effects of chemical exposures to children and estimating the toxicity of poorly tested (limited data) chemicals found in drinking water.

Partner: Minnesota Pollution Control Agency (MPCA)
Challenge: Evaluating risk of aquatic contaminants with minimal toxicity data
Resource: Extrapolation of species sensitivity and bioaccumulation to estimate potential impacts for contaminants of concern
Project Period: 2015 – Present

"EPA's variety of tools have been critical in developing aquatic toxicity profiles (ATPs) for contaminants detected across Minnesota. The MPCA uses EPA's estimation tools and databases to quickly obtain relevant information about contaminants that have only recently been detected in an aquatic environment. Prior to the development of these tools, information about contaminants has been limited or time-consuming to find. The profiles combine contaminant information such as fate in the environment, aquatic life toxicity, and endocrine activity to screen contaminants detected in Minnesota. The MPCA uses this information to communicate potential effects of the contaminants found in Minnesota and to identify pollution prevention opportunities for contaminants of highest concern." – MPCA, John Linc Stine (former Commissioner)

EPA ORD scientists support ongoing efforts in Minnesota to characterize potential effects for a wide variety of contaminants for which there exists limited information. MPCA uses a suite of EPA tools – Estimation Programs Interface (EPI) Suite, ECOTOX, Web-ICE – to prioritize chemicals based on toxicity effects and hazard characterization. Using these tools, MPCA develops toxicity profiles to screen contaminants that have been detected in the state, and then uses those profiles to prioritize chemicals for further monitoring or pollution prevention opportunities. The profiles are also used as a communication tool that the public or agency decision makers can access to get an overview of the potential hazards associated with individual contaminants detected in Minnesota. Specific recommendations are made to ensure the appropriate considerations are factored into future monitoring efforts (e.g., some contaminants have greater seasonal or geographical inputs, and some contaminants are more likely to partition to sediment or biota, and those matrices are important to sample in addition to water). By assessing the characteristics of the contaminants, future monitoring can be more strategic and less costly, yielding the most relevant data for those contaminants of highest concern.

As an example, during the development of an aquatic toxicity profile for triclocarban (an antibacterial agent common in personal care products like soaps and lotions), MPCA used EPISUITE to demonstrate a high potential for bioaccumulation and environmental persistence. They then used ECOTOX to obtain available toxicity information, which was used as input into Web-ICE to determine that the compound had high acute toxicity to a diversity of taxa. The toxicity profile resulted in the designation of triclocarban as a high priority contaminant for monitoring in systems with effluent input, with focus on sediment monitoring due to the potential to accumulate, persist and cause toxicity in sediment. The use of ORD tools allows MPCA to prioritize chemicals for monitoring to ensure resources address the contaminants of greatest environmental concern.

Partner: Utah Department of Environmental Quality (DEQ) Division of Water Quality (DWQ)
Challenge: Filling gaps in toxicity protocols and profiles for brine shrimp and brine flies of the Great Salt Lake
Resource: Technical support for the development and implementation of acute and chronic toxicity testing for Great Salt Lake brine shrimp and brine flies in order to site specific ambient water quality criteria
Project Period: 2013 – Present

"ORD's active participation with this project has brought a depth of expertise that Utah and Region 8 were simply unable to provide. The value of their technically sound and practical advice can't be overstated." – Utah DEQ/DWQ Environmental Toxicologist Chris Bittner

Utah's Great Salt Lake is the largest saltwater lake in the western hemisphere and the eighth largest terminal lake (no outlet) in the world. The Great Salt Lake supports 7.5 million birds and is designated as a habitat of hemispheric importance by the Western Hemisphere Shorebird Reserve Network. The lake contributes $1.1 billion annually to Utah's economy from mineral extraction industries and brine shrimp fishing. The lake is the ultimate receiving water for the wastewater of approximately 78% of Utah's population. Utah's population continues to increase putting additional stress on the lake's resources and services. The Great Salt Lake is both an economic and ecologic treasure, yet currently only has one water quality criterion (selenium).

National criteria are inappropriate for the Great Salt Lake because of elevated and variable salt concentrations that support an unusual ecosystem. Salt concentrations lake-wide range from freshwater to 27% which is about 8-times saltier than seawater. The ideal salinities for a healthy brine shrimp population range between 10 and 0% but less is known about brine flies. Little or no toxicity data are available for brine shrimp and brine flies, the two-keystone species supporting the waterfowl and shorebirds.

EPA ORD, in collaboration with EPA Region 8 (Mountains and Plains), assisted Utah DEQ/DWQ in the development and implementation of novel toxicity tests for brine shrimp and brine flies. For the metals and metalloids tested, the results demonstrate that brine shrimp are more sensitive than brine flies. These results will be published after peer review and then will be used to derive numeric water quality criteria to protect the resource. EPA remains committed to supporting Utah DEQ/DWQ and others' efforts to ensure that the water quality of Great Salt Lake continues to provide important recreational, ecological, and economic benefits for current and future generations.

Access Utah DEQ's *Proposed Approach for Developing Aquatic Life Numeric Criteria for Priority Pollutants* (published 2014).

Partners: Public health agencies of Arizona, Colorado, New Mexico and Utah; New Mexico Environment Department; New Mexico Environmental Public Health Tracking Program; New Mexico Department of Health Private Well Program
Challenge: Persistent environmental health disparities that are common to the four states such as heavy metal mixtures and well water concerns
Resource: Center for Native American Environmental Health Equity Research
Project Period: 2016 – Present

"The Center's research results informed the work on exposure assessments to metals from private drinking water conducted among communities in the Four Corners' states regions; we look forward to continuing this beneficial exchange of technical expertise." – New Mexico State Epidemiologist Mike Landen, PhD

Many Native American communities are impacted by mine wastes and heavy metal contamination from abandoned mines. There is also community concern about how these contaminants impact human health and cultural practices. To help address these challenges, the EPA and NIH have jointly funded the Center for Native American Environmental Health Equity Research.

The Center investigated various metal of concern (uranium, arsenic, manganese, mercury) and community- relevant metal mixtures in blood and urine samples obtained from community members. They also conducted mechanistic experimental studies to explore immunologic effects. The results of this research were presented at the *Four Corners States Biomonitoring Consortium* (4CSBC), organized by the state public health agencies of Arizona, Colorado, New Mexico and Utah. At the 2016 Annual 4CSBC Face-to-Face Meeting (September 28-30, 2016, Santa Fe, NM), the Center's Director presented and contributed to the discussion of biosample collection protocols (blood, urine). She applied the lessons learned in her center's previous Navajo Birth Cohort Study (funded by National Institute of Environmental Health Sciences) and subsequent analysis of biomonitoring for metals exposure conducted as part of the current center.

The Consortium developed three studies to investigate exposure and shared regional geophysical, cultural, economic, industrial, agricultural and political environment. For example, the consortium utilized the Center's findings as a starting point for a new study entitled, "The private well drinking water and metals contamination study." A study undertaken by the New Mexico Biomonitoring Program included environmental sampling and assessment of water quality from domestic wells. They conducted laboratory analysis of well-water samples for arsenic, cadmium, manganese, mercury, selenium, and uranium. Testing of water from domestic wells helped to identify potential sources of excessive exposures to those metals. Through this project, participants and communities learned about their water quality, and possible actions to control exposures. Ongoing efforts include investigating potential exposures to metals in drinking water across the state, investigating potential exposure to phthalates and other chemicals from the use of plastics and some consumer products, and chemicals used in some pesticides. At the local level, this collaborative project identified potential communities to include for monitoring, strengthened participant recruitment, and built collaborations with local governmental agencies and community coalitions in the recruitment and samples collection processes. The major impact of these efforts included developing states' capacity to conduct environmental exposure assessments through biomonitoring studies and investigating regional exposure concerns.

CHEMICALS – MERCURY

Partner: California Regional Water Control Board
Challenge: Reducing mercury methylation in the Nacimiento Reservoir
Resource: Technical investigation
Project Period: 2016 – 2017

"Understanding mercury methylation and cycling of mercury in the aquatic environment is particularly important to states and communities that oversee health advisories for fish consumption. The Lake Nacimiento study could help to enhance our understanding of mercury methylation and controls in reservoirs." – CalEPA Environmental Engineer Carrie Austin

Although operations ended in 1970, the legacy of previous mercury mining and processing activities at the Buena Vista, California, mining district still pose environmental and related public health concerns. Mercury from the Buena Vista Superfund site that enters the local watershed drains into the Nacimiento Reservoir. Researchers have identified active zones of methylation—when mercury is converted into a form that easily enters the food chain—in the reservoir's water columns and sediments.

Several remediation options are currently under consideration to protect the public from mercury exposure and its detrimental impact on the nervous system. Researchers from EPA ORD worked closely with their colleagues in EPA Region 9 (Pacific Southwest) to identify the best ones. Together, they worked to determine how much methyl mercury in the water column comes from methylation taking place in reservoir sediment, and to identify the effect that higher dissolved oxygen levels in the water column can have on the methylation process. Results showed that methylmercury production was primarily taking place within the water column, and that reservoir sediment was not a significant contributor due to much lower methylation rates; additionally, increased levels of dissolved oxygen would reduce overall water column methylation.

The information will help site managers focus on remediation activities that alter water column chemistry, increase levels of dissolved oxygen, and utilize reservoir management strategies, thereby reducing seasonal fluctuations of methyl mercury production.

A manuscript summarizing the research results was accepted for publication in the journal Environmental Pollution in September of 2022.

Partner: Minnesota Pollution Control Agency (MPCA)
Challenge: Addressing Beneficial Use Impairments through tracking and remediation of bioaccumulating contaminants
Resource: Modeling bioaccumulation of PCBs and mercury in fish
Project Period: 2017 – Present

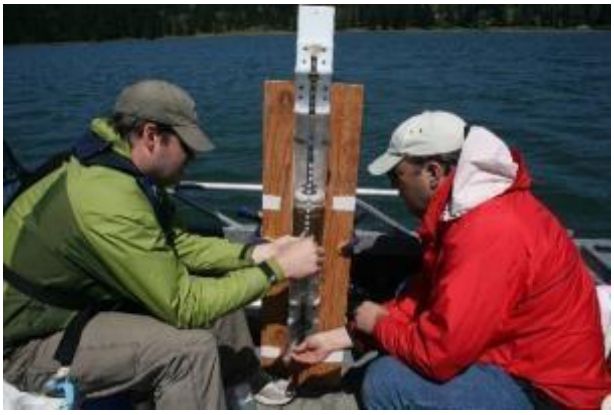
"EPA ORD's Great Lakes Toxicology and Ecology Division has been instrumental in providing data, analytical expertise and guidance to support MPCA's efforts to remove Beneficial Use Impairments (BUI's) in the St. Louis River Area of Concern (AOC) in Duluth, MN and Superior, WI. This AOC is the largest and most complex of the 43 legacy pollution sites surrounding the Great Lakes in the U.S. and Canada. EPA's work on aquatic macrophyte models, bioaccumulative compounds in fish tissue, benthic invertebrate communities and spatial data sets has accelerated the implementation of our plan to complete all project work in the AOC by 2020 so that BUI's can be removed by the target date of 2025." – MPCA John Linc Stine (former Commissioner)

The St. Louis River is listed as a Great Lakes Area of Concern (AOC) under the Great Lakes Water Quality Agreement of 1987. This AOC has several Beneficial Use Impairments including loss of fish and wildlife habitat, excess loadings of sediment and nutrients, degradation of aquatic invertebrate communities (benthos), and restrictions on fish and wildlife consumption. MPCA conveyed a need to identify improvements and advance progress toward removing use impairments and eventual AOC delisting.

One of the critical impairments identified for this AOC is restriction of fish and wildlife consumption. Both Minnesota and Wisconsin have posted fish consumption advisories for the St. Louis River because fish have elevated mercury and polychlorinated biphenyl (PCBs) concentrations. Bioaccumulation of dioxins and furans in the Thomson and Scanlon reservoirs are also a concern for fish, wildlife and human health. MPCA identified the need to develop approaches to establish remediation targets for these and other bioaccumulating contaminants, and monitoring designs to track progress after sediment remediation has occurred.

EPA ORD researchers worked with state agency staff to develop a geospatial, habitat-based model of fish bioaccumulation of PCBs to help determine the extent of PCB contamination in the AOC. The model is being used to screen for contamination "hot spots," determine remediation targets for contamination, and develop monitoring plans for future assessments. ORD researchers also led a multi-federal/state agency team to apply cutting-edge chemical tracers to identify the source and pathways of mercury contamination in the AOC. The tracers are being applied to determine the role of legacy mercury contamination in the AOC, and aid in establishing a mercury-specific remedial target. Finally, once the remediation of dioxins and furans in the Thomson and Scanlon reservoir occurs, state agencies will implement a tracking approach developed by EPA ORD researchers to determine success of the activities.

Partner: Oregon Department of Environmental Quality (DEQ)
Challenge: Determine the influence of water level fluctuations on the seasonal production of methyl mercury in the Cottage Grove Reservoir
Resources: Technical investigation to help reduce methyl mercury levels
Project Period: 2010 – 2018



"I think this is valuable information for understanding potential methyl mercury loading contributions and methylation mechanisms related to water level fluctuations in Cottage Grove Reservoir. Looking ahead, this study suggests some potential considerations related to reservoir flow management that could help mitigate mercury methylation potential." – Oregon DEQ, Water Quality Monitoring Manager Aaron Borisenko

The Cottage Grove Reservoir located south of the Historic Black Butte Superfund Site has received historical and ongoing loading of mercury and transport of contaminated mercury sediments resulting in strict fish consumption advisories. Cottage Grove Reservoir operates as a flood control reservoir, and lower water levels during the fall and winter expose 60-80 percent of the reservoir sediments.

EPA ORD researchers designed an investigation at Cottage Grove to determine whether the seasonal exposure of reservoir sediments was contributing to the elevated level of methyl mercury within the reservoir water column. Results from the investigation identified that the seasonal lowering of the water level corresponded with increased production of methyl mercury in sediments that were exposed to the atmosphere. Currently, discussions for altering reservoir management strategies to control seasonal production of methyl mercury are underway. By lowering the loading of mercury to the reservoir, Oregon DEQ hopes to benefit communities that catch and eat fish.

Additional information can be found in the fact sheet titled *EPA Cleans Up Furnace Creek Area at Black Butte.*

Two journal articles summarize the data from this project:

- Influence of Reservoir Water Level Fluctuations on Sediment Methylmercury Concentrations Downstream of the Historical Black Butte Mercury Mine, OR
- Water-level fluctuations influence sediment porewater chemistry and methylmercury production in a flood-control reservoir

Partner: Rhode Island Department of Environmental Management (RI DEM)
Challenge: Determining freshwater fishing sites for safe catch consumption and predicting accumulation of mercury (Hg) at untested sites
Resource: Sampling and analysis of mercury from fish tissues sampled across Rhode Island
Project Period: 2005 – 2019

"EPA ORD has been instrumental in providing technical expertise and analysis of total mercury concentrations in fish from freshwater sites in Rhode Island for over a decade. The data generated are reducing a major data gap and have been used by RI DEM to identify impaired waters under Section 303(d) of the federal Clean Water Act. The data are also reviewed by the RI Department of Health which provides advice to the public about fish consumption and mercury." – RI DEM Office of Water Resources, Deputy Chief Sue Kiernan

Mercury (Hg) is a highly toxic contaminant of concern because of its propensity to accumulate in aquatic organisms and to bio-magnify as it moves upward in aquatic food webs to fish. In New England, many lakes, ponds and reservoirs are acidic, unenriched and have conditions conducive to bacterial methylation of Hg. This methylation facilitates movement of mercury into aquatic food webs.

Due to concerns about mercury levels in freshwater fish in Rhode Island, scientists from EPA ORD worked with scientists in the RI DEM Office of Water and Division of Fish and Wildlife to sample fish and to determine their total Hg concentrations. This 15-year collaboration has resulted in the sampling and analysis of fish communities from more than 50 freshwater sites from locations across the state, including two sites on Narragansett Indian Lands. At more than 75% of sites, mercury concentrations were found to exceed the EPA tissue-based criteria for human consumption in higher trophic level fish, such as Largemouth Bass, Black Crappie and Chain Pickerel. As they were received, the results of fish Hg concentrations were shared with the RI Department of Health, which provided guidance on fish consumption to the public.

This cooperative research effort has also enabled EPA ORD scientists to measure stable isotopes of nitrogen and carbon on fish collected. These measurements have been used in corollary research to develop models for estimating trophic positions of different organisms in the food web. These models are useful for examining movement of energy and contaminants (including Hg) in aquatic systems.

Overall, this EPA ORD and RI DEM collaboration has helped determine which freshwater sites fishers can target for safe harvests and has provided data to develop models for predicting movement and accumulation of Hg in untested sites.

CHEMICALS – PFAS

Partner: Iowa Department of Natural Resources (DNR)
Challenge: PFAS-contaminated stormwater in a detention pond
Resource: Treatment options for the contaminated water
Project Period: January – March 2023

"We truly appreciate the partnership between EPA ORD and the Iowa DNR. ORD's timely guidance was valuable and helped us to expedite the project and ensure a successful completion." – Iowa DNR Environmental Services Division Administrator Ed Tormey

In January 2023, fire fighters used an aqueous film forming foam (AFFF) containing PFAS to extinguish a fire in Marengo, Iowa. The foam entered the stormwater collection system, resulting in an estimated twelve million gallons of PFAS-contaminated stormwater being held in a basin.

The PFAS concentrations were determined to be above levels appropriate for discharge into the Iowa River that serves as a drinking water source for many downstream communities, including Iowa City. Iowa DNR contacted EPA ORD to request help identifying options for treating the contaminated water. ORD staff met with colleagues from Iowa DNR to discuss the appropriate technologies. ORD researchers then ran models to estimate the effectiveness of the technologies, the optimal flow rates needed, and the length of time it would take to treat the total volume of water. This led to discussions on how those technologies would be implemented in the field. ORD contacted technology vendors and had meetings with Iowa DNR and the vendors discussing treatment options and remediation costs.

Ultimately, Iowa DNR chose a vendor, and a granular activated carbon (GAC) treatment system was installed. By that time, due to additional rain and wastewater treatment plant discharge, the total volume of water to be treated was approximately 13 million gallons. The stormwater retention basin was sealed off and the successful treatment of the water was completed before the rainy season, with no PFAS being detected in the water discharged to the Iowa River. This was the first time in Iowa DNR history that a large-scale, portable package plant was utilized to treat PFAS-contaminated water.

Partner: North Carolina Department of Environment Quality (NC DEQ)
Challenge: GenX PFAS contamination in the Cape Fear River
Resource: Technical assistance for a one-mile-long soil cement barrier wall and associated seepage control structures
Project Period: 2022 – Present

"EPA ORD scientists provided valuable technical support to NC DEQ in our oversight of the facility's remediation measures to reduce the levels of GenX and other PFAS reaching the Cape Fear River. The support during the design, installation and testing have helped ensure that the barrier wall and treatment system address a significant source of PFAS exposure for communities along the Cape Fear River." – NC DEQ Secretary Elizabeth S. Biser

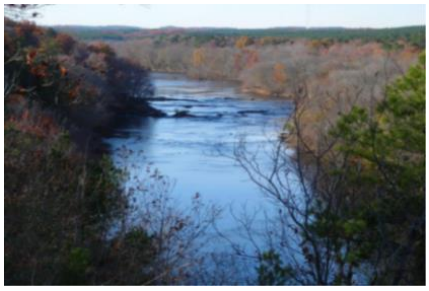
In 2017, the Cape Fear River, a public water source for Wilmington, North Carolina, was found to contain levels of concern for GenX compound of per- and polyfluoroalkyl substances (PFAS). State investigations determined that the unpermitted discharge of these hazardous chemicals into the Cape Fear River had come from the Chemours facility, a PFAS production site located near Fayetteville, NC.

In late 2022, EPA researchers, in collaboration with colleagues from EPA Region 4 (Southeast), began to assist the North Carolina Department of Environmental Quality (NC DEQ) in the remediation of GenX and other compounds from the Chemours chemical production facility that borders the Cape Fear River. EPA researchers provided technical support in reviewing the planning and construction of a one-mile-long underground soil cement barrier wall with associated seepage control structures, combined with a groundwater extraction and granulated activated carbon treatment system at the Chemours production site. These remediation components are designed to significantly reduce the PFAS levels going into the river through the containment and treatment of contaminated groundwater. NC DEQ also issued an NPDES permit for the groundwater treatment system. The permit contains technology-based effluent limitations that require the removal of greater than 99.9% of GenX and other PFAS compounds.

Agency scientists and the Region 4 team travelled to the site in April 2023 to meet with NC DEQ and observe the barrier wall installation and quality control testing. The completed barrier wall, seepage controls, and groundwater extraction system is designed to reduce the PFAS levels present in the Cape Fear Basin and protect the public drinking water that it supplies.

Partner: North Carolina Department of Environmental Quality, Cape Fear Public Utility Authority
Challenge: Removing PFAS from community drinking water with granular activated carbon
Project Period: 2017 – 2021

"EPA research has been extremely helpful to us in planning the startup operation of our GAC facility to reduce influent PFAS levels and meet various treatment goals. The Cape Fear Public Utility Authority (CFPUA) appreciates our partnership with EPA ORD in Cincinnati on the modeling of the GAC performance…it was very beneficial for our project and in communicating how our GAC facility will perform relative to EPA's proposed drinking water health advisories for PFAS." – CFPUA Deputy Executive Director Carel Vandermeyden



The Cape Fear Public Utility Authority (CFPUA) reached out to EPA ORD for help with plans to reduce PFAS from the community drinking water system, particularly with technical support for modeling pilot scale data. The partnership kicked off with a preliminary meeting held in Wilmington, NC with EPA Region 4 and the North Carolina Department of Environmental Quality. Since then, the partnership has led to a series of collaborative projects over several years. During this time, ORD researchers used data from two different long-term granular activated carbon (GAC) piloting exercises over multiple seasons. The pilot-scale data were fitted for 16 PFAS species and five commercial activated carbons using an EPA open-source pore and surface diffusion model that includes an automated parameter-fitting tool.

EPA's GAC model was then used to predict treatment effectiveness for different scenarios of interest to the utility. These included: how a particular full-scale design could handle fluctuating PFAS concentrations; how increased water demand or potential changes in prescribed treatment goals would affect treatment; and how different pretreatments or GAC choices might impact treatment effectiveness. The modeling also evaluated the optimal number of GAC contactors and their sizes. For all these analyses, uncertainty analyses were completed. Ultimately, what was learned supported the utility's decision to choose activated carbon and led to affordable, timely design and operational decisions that helped address the challenge of removing PFAS from the community drinking water system.

Partner: Alaska Department of Environmental Conservation (ADEC)
Challenge: Contaminated site due to PFAS issues at Joint Base Elmendorf-Richardson
Resource: Technical support for site contamination in collaboration with the U.S. Air Force
Project Period: 2016 – Present

"EPA's collaboration with the ADEC and the Air Force on PFAS sampling and analytical methods is key to ensuring valid, defensible data are collected on these emerging contaminants that are being found in soil, groundwater and drinking water in Alaska and elsewhere across the country. Extremely low concentrations, in the parts per trillion levels, in drinking water may pose unacceptable health risks, thus, rigorous sampling and analytical methods are critical in ensuring people have clean drinking water." – ADEC, Larry Hartig (former Commissioner)

With increased concern about the risk of per- and poly-fluorinated alkyl substances (PFAS) in drinking water, it is important to identify the source(s) of the contamination and manage/remediate the risk. To date, PFAS contamination has been observed at landfills, primary and secondary PFAS-related manufacturing sites, wastewater treatment plants, and emergency response and training sites where aqueous film forming foams (AFFF) were used for firefighting. The U.S. Department of Defense has identified hundreds of sites with potential AFFF contamination.

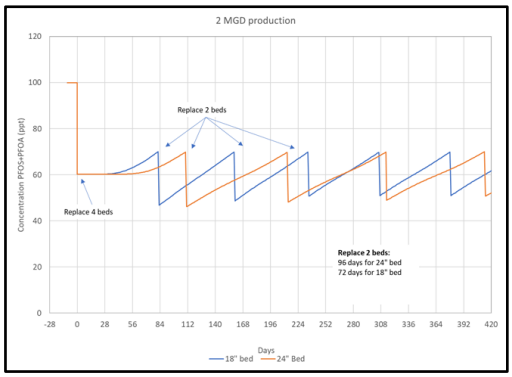
EPA ORD, in coordination with Region 10 (Pacific Northwest) and Region 5, is providing technical support for PFAS site characterization at Joint Base Elmendorf Richardson (JBER) in Anchorage. ORD previously provided a review of an Air Force work plan to collect groundwater and soil samples at JBER for PFAS analysis. ORD scientists observed the collection of groundwater samples by an Air Force contractor, visited locations where samples have been collected, and collected wastewater and creek samples. Region 5 scientists analyzed splits of some samples to evaluate the American Society for Testing and Materials (ASTM) analytical PFAS methods (ASTM 7968-14 and ASTM 7979-15, a preliminary version of SW-846 Method 8327). This sampling effort provided an opportunity to apply the ASTM methods to additional environmental matrices. In addition to the common PFAS analytes, samples were analyzed for PFAS precursors and transformation products. The analytical methods produced accurate and precise data for most analytes. Many groundwater locations contained PFOA and PFOS as well as other PFAS. The resulting data from EPA can be used to decide further site characterization priorities.

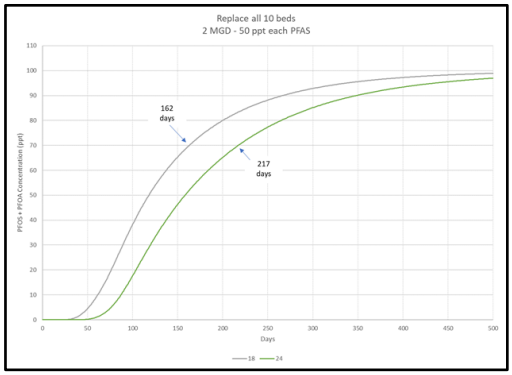
More information can be found on the Elmendorf Air Force Base and Fort Richardson Superfund site profiles.

Partner: Georgia Department of Natural Resources
Challenge: Understand effectiveness of granular activated carbon (GAC) for removing PFAS from a community drinking water system
Resource: Modeling and evaluating various design/operation configurations and lead/lag operations evaluations for GAC removal of PFAS
Project Period: 2020

"Georgia shout out to [EPA ORD] – the modeling analysis was very useful in helping Summerville develop their path forward!"
– Georgia DNR Watershed Compliance Program Manager Lewis Hays

The Georgia Department of Natural Resources and EPA Region 4 (Southeast) contacted EPA ORD seeking assistance on behalf of a Georgia community assessing the effectiveness of using granular activated carbon (GAC) for removing per- and polyfluoroalkyl substances (PFAS) from their drinking water. The community had sand filters that had been in service for years, and they were interested in replacing some or all of the sand with GAC to address PFAS removal.





In February 2020, ORD researchers modeled different local conditions to inform the choices the community was exploring. During these initial discussions, the objective was to understand how effective adding GAC to the current drinking water system would be for maintaining safe PFAS levels (EPA health advisory of PFOS + PFOA below 70 ng/ L) under the system's current production rates. This would then inform them as to whether they ultimately had to build a more robust system specifically set up for PFAS removal.

ORD provided actionable model results and consulted with their project partners from EPA Region 4 and the state on other technologies the utility could consider. The results of the modeling showed that GAC would likely provide PFAS removal at current treatment rates and provided some initial estimates for bed replacement intervals. This work highlighted that replacement of carbon in the current system could act as a stopgap measure to provide immediate treatment of PFAS to below the health advisory level, and it warranted an additional evaluation. Based on this work, the utility set up a confirmatory GAC test for evaluation.

Partner: Michigan Department of Environment, Great Lakes and Energy (EGLE)
Challenge: Understanding sources of PFAS from electroplating facilities
Resource: Sampling and analysis (both targeted and non-targeted) of PFAS in fume suppressants at electroplating facilities
Project Period: 2018 – 2020

"EGLE is grateful for the assistance provided by EPA Region 5 and ORD in investigating sources of PFOS. Their analysis demonstrated to chrome platers that the PFOS in their wastewater was not related to the PFAS in the fume suppressants that they currently use. Instead, the PFOS is likely the legacy from the previous generation of fume suppressants. This kind of information is invaluable to industries trying to reduce PFOS in their effluent to protect surface waters from these persistent pollutants." –Michigan PFAS Action Response Team (MPART) Executive Director Steve Sliver (retired)

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that include PFOA, PFOS, GenX and many other chemicals. There is evidence that exposure to PFAS can lead to adverse human health effects. Fume suppressants are commonly used by metal coating facilities to control air emissions and reduce worker exposure to hexavalent chromium, a known human carcinogen and inhalation hazard. While EPA required chrome platers to stop using PFOS-containing fume suppressants in chrome plating tanks in September 2015, some facilities that had stopped using PFOS-containing fume suppressants years ago were still discharging high concentrations of PFOS to sanitary sewers. These discharges caused municipal wastewater treatment plants to exceed state water quality standards. Exceedances continued even after extensive cleaning and disposal efforts. Industries and regulators were concerned that "PFOS-free" replacement products might still contain PFOS. To answer these questions, Michigan EGLE asked EPA ORD to conduct laboratory analysis of fume suppressant products and effluent from 11 Michigan chrome plating facilities to investigate PFAS.

EPA scientists used targeted and non-targeted analysis laboratory methods to identify and measure concentrations of PFAS in 12 fume suppressant samples and 11 effluent samples (collected prior to treatment for PFAS) from the chrome plating facilities. None of the currently used fume suppressants were found to contain detectable amounts of PFOS. In addition, none of the replacement products were found to contain PFOS precursors, which are specific PFAS that could break down into PFOS. In the targeted analysis, only one PFAS compound, 6:2 fluorotelomer sulfonates (FTS) was found in the currently used fume suppressants. Current discharges of PFOS are, therefore, assumed to be associated with historical use of PFOS-containing products.

EGLE used the information by provided by ORD to publish a report and conduct a successful webinar targeted toward the metal finishing industry to provide better understanding of sources of PFOS and how to reduce the amount of this pollutant released into the environment. EGLE has also shared this information with other state agencies as they work to address PFOS levels in their water systems.

Partner: New Hampshire Department of Environmental Services (NHDES)
Challenge: Understanding what perfluorochemicals (PFAS) are being emitted from industrial sources
Resource: Application of non-targeted high-resolution mass spectrometric methods to environmental characterization; air/stack sampling methods development and testing
Project Period: 2017 – Present

"EPA ORD's application of non-targeted high-resolution mass spectrometric methods to detect current PFAS emissions in air, water and soils has been a tremendous assist to NH as we assess emissions from current operations and treatment technologies to stop air emissions." – NHDES, Clark Freise (former Assistant Commissioner)

Following the emergence of concerns about long-chain per- and polyfluoroalkyl substances (PFAS), the state of New Hampshire has conducted extensive work characterizing "legacy" PFAS, primarily using contract laboratories.

However, there are ongoing technical challenges in this work, including: limitations in current analytical methods to comprehensively assess PFAS environmental contamination and related fate and transport expertise, handling more complex sample matrices, and the unknown nature of compounds. Regional, state, and contract laboratories are able to evaluate a relatively narrow slice of legacy PFAS, leaving environmental degradants and new generation PFAS invisible.

There are known industrial sources of PFAS along the Merrimack River. To evaluate the environmental and public health impact, NHDES requested EPA ORD's assistance to help them assess emissions and contamination comprehensively. Of particular interest is conducting novel analyses to reveal the possible presence of newer fluoropolymer materials. This has led to a strong collaborative effort with EPA Region 1 (New England) and NH collecting valuable samples and ORD applying novel methods of sampling (air) and analysis (non-targeted high-resolution mass spectrometry). Samples of water and soil had previously been collected to help understand the entirety of contamination that may have resulted from the operation of the plant. The collaborative effort has allowed an opportunity to engage in research to test new monitoring methods and instruments with the end goal of a comprehensive assessment of environmental contamination of per- and polyfluorinated materials.

As a result, eight data reports have been provided since April 2018 identifying PFAS in samples collected from various media within facilities and the surrounding environment. Analysis is ongoing, as well as employing non-targeted analysis techniques to identify novel PFAS. This work will help NHDES better understand the extent of contamination and determine the needs for and proper design of air pollution control equipment to control PFAS emissions.

Partner: New Jersey Department of Environmental Protection (DEP)
Challenge: Determining the scope of PFAS contamination
Resource: Water, soil and sediment analyses
Project Period: 2015 – Present

"EPA ORD's studies have provided critical information needed to develop PFAS human health risk assessments. In particular, we appreciate your foresight in initiating studies of PFNA several years before it was widely recognized as a potential concern. Also, we especially thank you for your ongoing willingness to share your knowledge of PFCs (perfluorinated compounds) in general, to answer all of our questions about your studies, and to continue working with us on identifying PFAS sources." – New Jersey DEP Research and Environmental Health, Division of Science, Gloria B. Post, PhD, DABT

A concern of New Jersey DEP is the ongoing presence of poly- and perfluoroalkyl substances (PFAS) in the drinking water resources of southwestern New Jersey. New Jersey DEP reached out to EPA ORD when they were faced with relatively high contaminant levels of a specific PFAS (perfluorononanoic acid, PFNA). New Jersey DEP continues to study the potential routes PFAS might be following in finding its way into these water resources. The chief questions are where the contamination is originating and whether it is getting into the water through direct discharge or through the air. The goals of this study are to confirm that PFAS contamination is occurring, establish specific PFAS source signatures, and evaluate the potential for impacts due to air deposition.

EPA ORD has provided nine data reports to NJ DEP since February 2019 identifying and quantifying PFAS in samples collected from various environmental media within the sampling area, including soils, vegetation, surface waters and groundwater wells. ORD analysis of results has shown promising methods for identifying source signatures and evaluating the effects of air deposition. For example, analysis of water and soil has found unique signatures of some manufactured PFAS and that by looking at the ratios of different PFAS, it is possible to identify a source signature that helps determine the contaminant's origin. Findings of the source identification project were published in the journal Science by EPA and NJDEP authors in June 2020. Results from a study on the effectiveness of point-of-entry granular activated carbon treatment for local residents was also published, in ES&T Letters.

New Jersey DEP has requested that ORD continue to work with them to analyze water, sediment, and soil samples for PFAS and their byproducts. NJDEP has recently conducted sampling at a manufacturing facility within the study area to continue investigations of the source of various PFAS. ORD will collaborate with New Jersey DEP to evaluate the data.

Partners: NC Department of Environmental Quality (DEQ), Cape Fear Public Utility Authority, Town of Pittsboro, Fayetteville, NC State Highway and Public Works Commission
Challenge: Mapping PFAS levels across an entire river basin
Resource: Methods development and laboratory analyses
Project Period: 2015 – Present

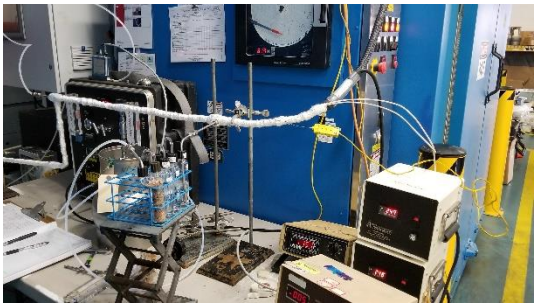
"We are extremely grateful for EPA ORD's work as we analyze these chemical compounds. EPA's analyses will be crucial to our efforts in protecting public health and the environment as we learn more about these emerging substances." – NC DEQ former Assistant Secretary Sheila Holman

Because of concerns about long-chain per- and polyfluoroalkyl substances (PFAS), which persist in the environment, their use began being phased out in 2006. In 2007, EPA ORD began a first-ever effort in the U.S. to map PFAS levels in an entire watershed, focusing on North Carolina's Cape Fear River Basin. This mapping effort demonstrated that there were multiple sources of many different PFAS throughout the basin, suggesting that since the basin is a major drinking water resource, it could potentially be responsible for human exposures to PFAS throughout the entire region. As part of this effort, EPA ORD also developed research-based methods to measure PFAS in drinking water and detect novel PFAS using high resolution mass spectrometry non-targeted analysis approaches.

EPA ORD's PFAS research in the Cape Fear Basin has continued to evolve. Having largely addressed PFAS wastewater discharge to the Cape Fear River, attention has turned toward air emissions, fate, transport, deposition, and resulting land and surface water contamination down wind of the Chemours plant. EPA ORD is working with Region 4 and NC DEQ to test and deploy air sampling methods including the application of non-targeted analysis to comprehensively characterize air emissions. NC DEQ is also sampling and making available rainwater for testing. This work is being done cooperatively with Chemours to evaluate air emissions control technology that they are considering. These efforts are expected to provide solutions for reducing exposures to these potentially hazardous chemicals.

Access EPA publications related to PFAS research in North Carolina.

Partner: New York State Department of Environmental Conservation (NYSDEC)
Challenge: Understanding VOC and air emissions from PTFE product manufacturing facilities
Resource: Sampling and analysis (both targeted and non-targeted) of air emissions from PTFE manufacturing facilities
Project Period: July 2018 – August 2020



"As PFAS are a significant concern, better understanding air emissions at a facility that uses PFAS to manufacture products is very helpful. Knowing what chemicals are emitted will help NYSDEC characterize PFAS emissions and determine the need for the installation of air pollution controls. Our collaborative work with EPA on this project was invaluable. " – NYSDEC Research Scientist Tom Gentile

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that include, among others, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and GenX. There is evidence that exposure to PFAS can lead to adverse human health effects. PFOA is a PFAS that was widely used as a processing aid to manufacture nonstick coatings (polytetrafluoroethylene [PTFE]) and other fluoropolymers. PFAS manufacturing facilities may emit PFAS and other volatile organic compounds (VOCs) into the air.

At the request of the New York State Department of Environmental Conservation (NYSDEC), scientists from EPA's Office of Research and Development (ORD) conducted an independent study to qualitatively identify PFAS and PTFE thermal degradation products in air emissions at a manufacturing facility in New York State where bulk PTFE is molded and sintered.

ORD scientists collected air emission samples from the process exhaust at the industrial facility and used targeted and nontargeted laboratory analytical methods to qualitatively analyze the samples for VOCs, PTFE thermal degradation products, and water-soluble PFAS compounds. Investigating the potential presence of PFOA was the primary targeted measurement of interest. PFOA was determined to not be present in any of the process exhaust emissions measurements.

EPA shared a report of its study with NYSDEC. The information was also shared by NYSDEC with local elected officials and the public at a community meeting. The information helped NYSDEC characterize PFAS emissions from a PTFE manufacturing facility that processes raw PTFE powdered resins into final products. The qualitative analysis and other factors were used to assess the need for air pollution controls on this process operation.

Partner: Michigan PFAS Action Response Team (MPART)
Challenge: Limited understanding of technologies for the ultimate disposal of PFAS waste
Resource: Quarterly meetings with MPART members and EPA scientists to share the latest advances in PFAS destruction research and technologies
Project Period: 2020 – Present

"We are pleased to partner with EPA ORD in identifying and evaluating treatment technologies that break the cycle of PFAS recirculating in the environment. This collaboration is an excellent opportunity to combine ORD's leading-edge technical research with the data being generated from Michigan's ongoing field work to address PFAS contamination and will help guide our collective efforts to identify and test the most effective treatment solutions." – MPART Executive Director Steve Sliver (retired)

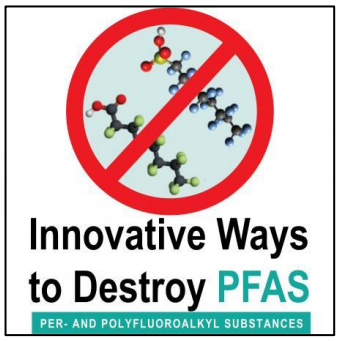
Per- and polyfluoroalkyl substances (PFAS) are a very large class of man-made chemicals that include PFOA, PFOS and GenX chemicals and are found in everyday items such as food packaging, non-stick stain repellent, waterproof products, and firefighting applications. PFAS can enter the environment through production or waste streams and can be very persistent in the environment and the human body. PFAS have many and varied pathways into waste streams, presenting challenges for ultimate disposal. Determining the appropriate method for ultimate disposal of PFAS wastes is a complex issue due to their volatility, solubility, and environmental mobility and persistence. EPA is currently considering multiple disposal techniques, including incineration and novel non-thermal ways, to effectively treat and dispose of PFAS waste.

Since early 2020, EPA ORD and the Michigan PFAS Action Response Team (MPART) have held regular meetings for MPART members and EPA ORD scientists to share the latest advances in PFAS destruction research and technologies. These calls have helped align EPA's research programs with state needs related to PFAS. EPA ORD was pleased to partner with MPART and others on the Innovative Ways to Destroy PFAS Challenge to discover new non-thermal technologies and approaches that can remove PFAS in unused aqueous film forming foam (AFFF), without creating any harmful byproducts.

MPART is an interagency workgroup established in 2019 consisting of members from Michigan's Department of Environment, Great Lakes and Energy; Department of Health and Human Services; Department of Agriculture and Rural Development; Department of Natural Resources; Department of Transportation; Department of Licensing and Regulatory Affairs; and Department of Military and Veterans Affairs.

Learn more about EPA's research on PFAS.

Partners: Environmental Council of States (ECOS) and its research arm, the Environmental Research Institute of the States (ERIS)**;** Michigan Department of Environment, Great Lakes & Energy (EGLE); Colorado Department of Public Health & Environment (CDPHE)
Challenge: Discover novel non-thermal way(s) of destroying PFAS in concentrated firefighting foam
Resource: Crowdsourcing innovative solutions through the challenge.gov platform, in collaboration with U.S. Department of Defense's Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP)
Project Period: 2020 – 2021



"The collective creativity and ingenuity of participants from diverse backgrounds is what makes challenges like this so successful. We hope rewarding the creators of these innovative concepts helps to make these technologies a reality so that federal, state, tribal, and local partners can safely destroy PFAS in firefighting foams." – Pennsylvania Department of Environmental Protection former Secretary Patrick McDonnell (former ECOS President)

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been widely used for more than 60 years to make plastics, firefighting foams, and lubricants, and to help make products stain-resistant, waterproof, and nonstick. Addressing and managing PFAS in the environment is one of the most pressing issues facing EPA, states, tribes and regions.

PFAS compounds are difficult to destroy because their unique chemical characteristics rely on very strong chemical bonds. EPA is investigating all methods of destroying PFAS. Incineration has been used to treat PFAS-contaminated media, and EPA scientists collaborated with the private sector to evaluate the effectiveness of thermal treatment technologies to completely destroy PFAS. EPA partnered with the U.S. Department of Defense, ECOS/ERIS, Michigan EGLE, and CDPHE in a challenge to identify a non-thermal way of destroying at least 99 percent of PFAS in concentrated aqueous film forming foam (AFFF), a type of firefighting foam, without creating any harmful byproducts. Although PFAS compounds can be found in various waste streams, the challenge was focused on unused AFFF.

The Innovative Ways to Destroy PFAS Challenge was launched in August 2020 and accepted applicants until November 2020. The Judging Panel, composed of EPA scientists, engineers and other technical experts, including subject matter experts from the partners for this Challenge, evaluated the submissions and announced winners in late spring 2021. The agency awarded $40K to the first place winner and $10K to each of the second place winners.

Learn more about EPA's research on PFAS.

Partner: Interstate Technology and Regulatory Council (ITRC)
Challenge: Need for improved understanding of the current science regarding PFAS
Resource: Technical resources including fact sheets, a web-based technical and regulatory guidance document, and online training materials
Project Period: 2017 – Present

"As ITRC PFAS Team members, EPA staff continue to contribute valuable input and guidance to support the Team mission of developing materials that can be used by decision makers to address environmental challenges associated with PFAS contamination." – New Jersey DEP Sandra Goodrow and Vermont DEC Kristi Herzer (ITRC PFAS Team Leads)

Per- and polyfluoroalkyl substances (PFAS) are a large and complex class of anthropogenic compounds whose prevalence in the environment are an emerging, worldwide priority in environmental and human health. Some PFAS are environmentally persistent and bioaccumulative and may pose human health risks. There is a growing need for regulators, project managers, and other stakeholders to improve their understanding of the current science regarding PFAS.

The ITRC PFAS Team, formed in 2017, has prepared readily accessible materials to present PFAS information to stakeholders, regulators, and policy makers. The PFAS team represents a diverse cross-section of expertise and experience working on PFAS. In 2023, the team membership includes more than 50 active state, city and local representatives. State participation, including interested parties, comes from 44 states and the District of Columbia. The team membership also includes representatives from the federal government, academia, public and tribal stakeholders, consulting, industry, and international governments. EPA scientists participate on the team, providing their technical expertise, collaborating through discussions and meetings, and by providing written comments on draft ITRC PFAS materials. EPA has shared knowledge of emerging issues and research in a variety of topic areas, which is incorporated into many document sections: sampling and analysis; site characterization, fate and transport; occurrence in the environment; chemistry and naming conventions; physical and chemical properties; history and use; aqueous film-forming foam (AFFF); treatment; toxicity and risk assessment; and regulations and guidance. These materials can be used to foster development of a broad technical understanding necessary for informed and expedited decisions to address PFAS impacts to human health and the environment. The ITRC PFAS technical resource materials include:

- A series of fact sheets that synthesize key information for core subjects including fate and transport, sampling precautions, analytical methods and more. The newest fact sheet (published October 2022) includes information about Biosolids. Updated fact sheets are planned for September 2023. Eleven fact sheets have been posted in Spanish and five in Portuguese.
- A web-based technical and regulatory guidance document first published in 2020 presents a wide range of technical topics for PFAS, provides references to scientific literature and state and federal documents, and includes stakeholder points of view, technical challenges and uncertainties, and risk communication strategies. The document was updated in 2021 and 2022. ITRC is continuing to develop new content to reflect the rapidly evolving science and regulatory approaches for PFAS and plans to publish the new content in September 2023.

- External Data Tables that compile key information on focused topics, including the PFAS Water and Soil Regulatory and Guidance Values table, the Aquatic Organism BAF table, and many others.
- Online training materials that convey the information presented in the technical and regulatory guidance document. Additionally, the team provided in-person and online training workshops to approximately 3,000 attendees from 2018 to 2020. In 2020 and 2021, the team launched a new training format and held 4 roundtable webinars on select PFAS topics. During 2022 and 2023 additional workshops and webinars were provided. In April 2023, PFAS team members presented a 90-minute, PFAS 101 webinar on the Clu-In platform an archive of which is available for viewing. ITRC is planning to develop several more advanced content webinars on PFAS topics.

Partners: Environmental Council of the States (ECOS), Environmental Research Institute of the States (ERIS), Association of State and Territorial Health Officials (ASTHO) and member states
Challenge: Understand PFAS science & technology challenges in environmental media
Resource: State-federal dialogue and presentations on evolving PFAS science
Project Period: 2017 – Present

"State-federal dialogue is critical to better understanding the science surrounding complex and multifaceted issues like PFAS. These calls are an example of the coordination necessary to foster research and technical capabilities." – ERIS Board member David Paylor (former Director of the Virginia Department of Environmental Quality)

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been widely used for more than 60 years to make plastics, firefighting foams, and lubricants, and to help make products stain-resistant, waterproof, and nonstick. Addressing and managing PFAS in the environment is one of the most pressing issues facing EPA, states and regions.

EPA hosts a bimonthly call with the Environmental Council of the States (ECOS, the national association of state environmental agency leaders) and the Association of State and Territorial Health Officials (ASTHO, the national association of state and territorial chief health officials) and interested state representatives on PFAS. These calls are an opportunity for EPA scientists and our state partners to share evolving PFAS science. Topics include analytical methods, human health and toxicity, site characterization, exposure, remediation, and treatment work. Both states and EPA present on a wide range of topics. More than 40 states regularly participate on these calls.

EPA ORD has gained a better understanding of the science needed to address real-world PFAS environmental challenges. This has helped us provide innovative and multidisciplinary research to underpin decisions and help develop science-based tools and resources that states can use to protect human health and the environment. Joint efforts like our work with ECOS and ASTHO strengthen the alignment of EPA's scientific and technical capabilities with state needs and have better connected EPA and state scientists to help fill knowledge gaps. EPA scientists will continue to collaborate with our state partners as PFAS research continues to expand.

For more information, please visit PFAS Resources for States and EPA's PFAS Research website.

Partners: Association of State and Territorial Health Officials (ASTHO), Environmental Council of the States (ECOS), and state environmental or health agencies (CO, IN, MI, MN, MO, NC, NH, NY, OH, OR, PA, UT and VT)
Challenge: Improve risk communication strategies for PFAS and harmful algal blooms
Resource: State-level case studies, tools, materials, and strategies for risk communication
Project Period: 2018 – 2019

"State health and environmental agencies are relied upon by the public to alert impacted communities of risks associated with waterborne contaminants, including PFAS and HABs. The way that these risks are messaged is important in gaining credibility and trust in our governmental partners, so it is important to frame the messages in a unified manner. This project provided a critical opportunity for several states to share how they have developed their health advisories and accompanying media releases, striking a balance between being transparent with known risks but also recognizing potential unknowns associated with the complex contaminant challenges." – ASTHO Health Security Vice President Meredith Allen, DrPH

Per- and polyfluoroalkyl substances (PFAS) and harmful algal blooms (HABs) are priority environmental issues for states. Proper risk communication is needed to inform the public of PFAS- and HABs-related issues without causing panic. There is also the balance of communicating what different health departments, environmental agencies, and water systems can and cannot do to address the issues. EPA partnered with the ASTHO and ECOS on a collaborative to highlight state-level risk communication of these PFAS and HABs, through our Memorandum of Agreement on environmental health.

In early 2018, ASTHO and ECOS interviewed health and environmental agency staff from 13 states about their risk communication strategies and lessons learned for either PFAS contamination or HABs. ASTHO and ECOS collected information on how selected states' health and environmental agencies have been addressing PFAS and HABs, including the wording of accompanying risk communication/health advisories and the methods used to communicate them to the public. ASTHO and ECOS compiled the findings to share with other states who are looking to update or create new advisories and supporting risk communication materials for their own jurisdictions.

In 2019, using lessons learned from the previous year's effort, ASTHO and ECOS compiled existing tools, materials, and strategies for PFAS risk communication. Known as the PFAS Risk Communications Hub, the goals were 1) to increase collaboration between state environmental and health managers, 2) increase accessibility of risk communication models for states and communities, and 3) improve public health through awareness of potential risks of contaminants of emerging concern.

- ECOS - Case Studies on State-Level Risk Communication of PFAS and HABs
- ECOS - PFAS Risk Communication Hub
- ASTHO – PFAS Risk Communication Hub

COMMUNITY RESOURCES

Partner: Environmental Council of the States (ECOS), Association of State and Territorial Health Officials (ASTHO), and Association of Fish and Wildlife Agencies (AFWA)
Challenge: Collaborating with state environmental, health, and fish & wildlife agencies to tackle environmental challenges
Resource: Webinars, workshop, Community of Practice
Project Period: 2021 – Present

"The Association of Fish and Wildlife Agencies (AFWA) values and appreciates the partnership with US EPA, the Environmental Council of the States (ECOS), and the Association of State and Territorial Health Officials (ASTHO) to raise awareness, expand collaboration, and support communication on One Health. EPA is serving an important role as a convenor to bring together practitioners across multiple sectors and disciplines to improve human, environmental and animal health." – AWFA President and Director of the Oregon Department of Fish and Wildlife Curt Melcher

One Health is a collaborative, multisectoral and trans-disciplinary approach—working at local, regional, national and global levels—to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants and their shared environment. Since 2021, EPA ORD has been collaborating with our state partners at the Association of Fish and Wildlife Agencies (AFWA), the Association of State and Territorial Health Officials (ASTHO), and the Environmental Council of the States (ECOS) to raise awareness of and promote the One Health framework to tackle environmental challenges.

EPA ORD and our state partners hosted two webinars and one workshop in 2021 to promote the One Health approach and to identify potential collaborative project ideas. The webinars served to discuss the importance of the One Health approach and the role of different environmental, health and animal professionals within the One Health framework. View recordings of the webinars here. The goal of the small workshop, held in December 2021, was to further explore One Health topics of interest to states and EPA with practitioners, build and enhance relationships between state environmental, health, and natural resource/fish and wildlife agencies, and identify potential One Health projects to collaborate on at both the state and national levels that will benefit states.

One idea that came out of the workshop was to host a One Health Community of Practice (CoP). In 2022, EPA and our state partners kicked off the One Health CoP and held a total of three calls throughout the year. Highlights included state examples from Missouri and Alaska. Read more about the Missouri example here. The quarterly CoP has continued into 2023 and is also open to our Tribal and federal partners. These meetings focus on the environmental pillar of One Health and missions that are relevant to EPA and our partners. EPA and our state partners held a joint webinar to highlight all of the above mentioned One Health efforts and more on November 16, 2022. View the webinar recording here.

Learn more about One Health at EPA.

Partner: California Energy Commission
Challenge: Population and land use projections to the year 2100 consistent with emissions storylines
Resource: Integrated Climate and Land Use Scenarios (ICLUS) version 2
Project Period: 2012 – 2019

"It is extraordinarily beneficial to climate planning in California to be able to rely on tools like ICLUS v2 to provide a federally-vetted baseline for coordinated climate assessment research." – California Natural Resources Agency, former Special Assistant for Climate Change JR De la Rosa

EPA ORD researchers developed national population, land use and impervious surface projections that the state of California used in its Third Climate Change Assessment. For the fourth assessment, the state used EPA's updated climate model, the Integrated Climate and Land Use Scenarios version 2 (ICLUS v2), as a basis for land use scenarios in California, with minor modifications as necessary. These scenarios were used across multi-disciplinary and multi- sectoral research that informs the Fourth Assessment.

ICLUS v2 uses the latest census, land use and land cover datasets to model population growth, residential housing changes, and commercial and industrial development nationally to the year 2100. Projections use information on fertility, mortality and international immigration rates that are consistent with global storylines (e.g., Shared Socioeconomic Pathways) used in climate change impacts, vulnerability and adaptation assessments. In addition, ICLUS v2 projections use information on domestic migration, including how future climate may make certain places more desirable. Combined with the addition of commercial and industrial land uses, the updated projections from ICLUS v2 helped the state of California better assess potential future impacts from climate change and prepare adaptation and mitigation responses.

Partners: California State University (CSU) System
Challenge: Framework and decision support tools to advance priority projects in local government work plans
Resource: Supporting campus-community partnerships through the EPIC Framework and EPA tools
Project Period: 2015 – Present




"This model shows us how to work together with the university to create a meaningful partnership to take on projects the city needs done. EPA has been an integral part of making this happen. It gave credibility to the project, to our city manager…. we're very thankful for their participation in bringing this together." – City of Chico Council Member and former Mayor Ann Schwab

Environmental and public health impacts affect people most significantly at the local level where there is often a lack of capacity and need of assistance managing pollution, natural resources, energy, water, and waste. The Educational Partnership for Innovation in Communities (EPIC) model is a partnership framework where a university (campus) provides direct support to a city, tribe or other local government entity to implement priorities and projects that align with local goals for protecting the environment while advancing public health, environmental justice, and economic outcomes. The EPIC framework systematically matches real-world interests and needs with university capacity at a scale that can have lasting and sustainable impacts for all involved.

EPA ORD and EPA Region 9 (Pacific Southwest) staff have been working together to convene and educate potential campus- city partners about the framework; and leverage the EPIC Network to more effectively share EPA resources and science-based decision tools and strategies that can be used to advance local projects. In July 2015, EPA sponsored a workshop in California that convened 76 participants including federal and local government, university, and industry representatives to educate them on the EPIC Framework and EPA tools for protecting the environment while promoting local heath and economic goals.

From this workshop, six new California EPIC programs formed between California State Universities and local governments. Through these programs with the universities' first city partners, 1601 students completed 35 city priority projects gaining real-world learning experiences applying 103,500 student hours to local challenges. One new program launched in 2021, and there are several more CSU universities that expressed interest in developing EPIC programs and using ORD tools. Another result is that in 2020, ORD and EPIC-N signed an MOU to 1) further advance campus-community partnerships and the use of science-based tools and resources to support the environmental, public health, and revitalization efforts of local communities; and 2) research, understand, and communicate best practices of communities in supporting local resilience. For information on the EPIC model and network of universities that use it, visit epicn.org.

Partners: Florida Department of Health (FDOH), University of Florida
Challenge: Effectively communicating technical guidance for safely remediating flooded homes
Resource: Risk communication tools to promote community resilience after flooding events, in collaboration with the Centers for Disease Control and Prevention (CDC), Agency for Toxic Substances and Disease Registry (ATSDR), Federal Emergency Management Agency (FEMA), U.S. Department of Housing and Urban Development (HUD), U.S. Office of Personnel Management (OPM), Louisiana State University, and the University of Missouri
Project Period: 2019 – Present

"Environmental health hazards such as mold, lead, asbestos and carbon monoxide associated with flooded homes present a unique and challenging problem for homeowners and renters in Florida and elsewhere. We believe this collaborative project will help folks to understand how to safely reduce risks to their health while restoring their homes and lives." – Florida DOH Bureau of Environmental Health Chief and State Toxicologist Kendra Goff, PhD, DABT, CPM, CEHP

Florida residents face health risks from flooding, including indoor air quality hazards in flooded homes. Every year, the Florida Department of Health (FDOH) and the University of Florida Institute of Food and Agricultural Sciences (UF IFAS) provide technical guidance on ways to safely clean up a flooded home. The existing resources are not widely utilized and can be challenging to understand. To better inform the public about risks—and actions they can take to reduce them—EPA is partnering with Florida DOH, UF IFAS, other federal agencies (CDC, ATSDR, FEMA, and HUD) and experts from Louisiana State University and the University of Missouri. Together, they are developing a strategically designed website that includes how-to videos, infographics, and other materials designed to inform the types of decisions flood survivors have to make about their homes and the social context in which they make those decisions.

EPA ORD, in collaboration with EPA Region 4 (Southeast), utilized human-centered design and disaster anthropology to create an innovative risk communication strategy to produce materials targeted to people impacted by flooding. To do so, EPA and partners interviewed residents of Florida and other states who had recently experienced flooding due to Hurricanes Dorian, Michael, and Irma. Based on what they learned, the researchers created a website tailored to homeowners, renters and volunteers working to fix up flooded homes.

The publicly available website is available at: www.epa.gov/flooded-homes. This resource will improve the resiliency of communities facing flood and other disasters involving water intrusion in their homes.

Partners: Massachusetts Bays National Estuary Partnership, Pennsylvania Department of Environmental Protection, Puerto Rico Department of Natural and Environmental Resources, Chesapeake Bay Program partners, Mobile Bay National Estuary Program
Challenge: Communicate the potential social and economic benefits of habitat and ecosystem restoration projects
Resource: Technical support to identify and quantify ecosystem services
Project Period: 2019 – 2022

"The Massachusetts Bays National Estuary Partnership has been fortunate to work with researchers in EPA's Office of Research and Development on multiple projects. ORD's broad and deep expertise has enabled us to implement programs we would not have been able to ourselves (like the Biological Condition Gradient). ORD scientists are committed to the practical side of science, helping us to realize improvements in local ecosystems, working alongside local decision makers." – Massachusetts Bays National Estuary Partnership Director Pam DiBona

Natural resource protection and restoration goals are often tied to "ecosystem services," the benefits people get from nature, such as fishing or recreation. Yet the metrics of these benefits are not often used to plan, implement, and monitor ecological restoration. Instead, the focus is usually on biological structure or ecological function, which fail to adequately communicate the potential social or economic benefits of such efforts.

State and local partners have expressed a priority need for ways to systematically characterize and measure ecosystem services to support their efforts to identify, maintain, and restore high quality natural resources. For example, EPA has been working with National Estuary Programs and Puerto Rico to characterize biological condition of estuaries and coral reefs, and to understand how conditions effect the availability of the ecosystem services these habitats provide, such as flood mitigation, fishing, and recreation. In addition, state and academic partners in Chesapeake Bay and East Mount Zion, Pennsylvania, are working with EPA researchers to identify and compare the potential benefits of different restoration options and motivate implementation of more projects.

Many state and coastal programs use a Biological Condition Gradient (BCG) system—which characterizes conditions from "severely altered" to "natural condition"—to guide restoration targets for coastal and stream ecosystems. EPA researchers are working with their partners to develop an ecosystem services analog to the BCG, the Ecosystem Services Gradient (ESG). This research will describe the potential range of ecosystem services along a gradient of biological condition from highly degraded to fully restored. The process includes identifying the ecosystem services that are most relevant to stakeholders and the attributes of the biophysical condition that provide such services. This research will help partners better identify what levels of restoration are needed to achieve beneficial use goals, communicate potential benefits or tradeoffs of environmental management decisions to the public, and monitor the effectiveness of restoration projects toward achieving those goals.

Learn more about how EPA research supports National Estuary Programs.

Partners: Citizen Schools, Duke Energy Initiative, Durham Children's Initiative, Durham Public Schools Science Alliance, NC Science Festival , NC Science Mathematics and Technology Education Center, NC State University Kenan Fellows Program for Teacher Leadership, Project PEACE, Research Triangle Cleantech Cluster Triangle Women in STEM, RTP Foundation, WakeEd Partnership
Challenge: Preparing the future environmental health workforce by providing STEM (science, technology, engineering and math) education, especially in K-12 schools with low-income populations
Resource: EPA's Community Engagement & STEM Education Program in Research Triangle Park (RTP), NC
Project Period: 2003 – Present

"EPA's Community Engagement and STEM Education Program in RTP has not only has been a source of ideas for our own outreach program improvement but also serves as a model STEM outreach organization in the region, because of its impactful work in schools, museums, and on-site for students of all ages through speed mentoring, job shadowing, and hands-on STEM activities."
– The Research Triangle Foundation, STEM in the Park Outreach Program Manager Sarah Council Windsor

EPA's Community Engagement & STEM Education Program (CE-STEM) communicates EPA science to K-12 and university students, to educators and to the public. CE-STEM outreach at schools, community events, and at EPA-RTP increases the public's knowledge of how protecting the environment protects human health. Most CE-STEM programming serves students at low-income schools (i.e., 50%+ free/reduced lunch) to help close the opportunity gap and build capacity for a more diverse workforce. CE-STEM also provides training and guidance to EPA regional offices and labs, as well as to U.S. embassies. CE-STEM was initiated in 2003 and typically reaches more than 25,000 people at 350 plus events, mostly in central NC, through the participation of more than 200 EPA-RTP employees. In March 2020, CE-STEM pivoted to providing programming via online platforms which expanding our geographic reach.

CE-STEM engages the public in protecting human health and the environment by:

- Establishing relationships with educators and local, regional, state, national and international stakeholders;
- Translating EPA science into hands-on activities and lessons for employees to use in the community;
- Recruiting and training EPA employees to educate K-12 students, college/university students and the public at school, community events and at EPA-RTP; and
- Building capacity for an educated, informed, diverse and inclusive pipeline of future EPA employees and environmental decision makers.

CE-STEM was awarded two US2020 STEM mentoring awards in 2017 – one for Excellence in Volunteer Experience, and a second for Volunteer Mobilization. The Excellence in Volunteer Experience Award recognizes STEM programs that provide high-quality, well-supported STEM activities for their volunteers, while the Volunteer Mobilization Award honors organizations that effectively engage their workforce to support youth-serving organizations. In 2019, the Research Triangle Cleantech Cluster recognized CE-STEM with the Diversity Initiative of the Year at their Cleantech Innovation Awards. In 2020, the program received the Research Triangle Cleantech Cluster Talent Initiative of the Year Award, as well as STEM RTP's Community Serving Organization of the Year Award.

Partner: Environmental Council of the States (ECOS), E-Enterprise Leadership Council (EELC), Association of Public Health Laboratories (APHL)
Challenge: Improving the value of participatory science data in environmental decisions
Resource: Methods for using community and citizen science in EPA, state and Tribal environmental programs
Project Period: 2019 – Present

"State agencies appreciate working with EPA ORD on these community and citizen science case studies to increase effectiveness in gathering reliable air and water data to fill information gaps, monitor environmental changes, and assist in understanding conditions in underserved areas." – ECOS Executive Director Ben Grumbles (former Secretary of the Maryland Department of the Environment)

Participatory science is the involvement of the public in expanding scientific knowledge and understanding, often in collaboration with scientists and institutions. It uses the collective strength of communities and the public to identify research questions, collect and analyze data, interpret results, make new discoveries, and develop technologies and applications. Often referred to as citizen or community science, EPA transitioned to the term "participatory science" in June 2022 to represent the most inclusive and accessible involvement of the public in the scientific process, especially those who have been historically underrepresented in the field.

In October 2020, the Environmental Law Institute (ELI) released a report, supported by EPA, of how participatory science is used in state and Tribal environmental programs. A Tribal participatory science paper, prepared by Tribal members of EELC, contains eight case studies, an overview of best practices, and recommendations for how EPA and other organizations can better support Tribal participatory science. In addition, EPA collaborated with ELI and APHL to prepare outreach and training on EPA's Citizen Science Quality Assurance Handbook, including fact sheets, infographics, and on-line training video modules. A plain language orientation guide was developed to explain how to design participatory science projects so data collected can contribute to environmental decisions, including information on potential roles for state, Tribal, and local agencies to provide technical support and advice.

EPA funded five Tribal participatory science projects in 2020, including an air sensor equipment loan program; a community social science study on backhauling hazardous waste from Alaskan villages; and tools and training on community monitoring of harmful algal blooms. State projects funded in 2020 include testing of passive sampling technology for stream monitoring in Kansas; evaluating air pollution sensors for hot spot monitoring in New Jersey; and using social science to create cleaner residential recycling streams in Colorado and Delaware.

In 2021, EPA continued analysis and support of Tribal participatory science, and outreach and training opportunities with APHL on the EPA QA handbook for participatory science. EPA also held an interactive, multi-stakeholder workshop in 2021, co-sponsored with EELC, on improving data management for participatory science projects. An invited group of state, Tribal and EPA staff, as well as academic and NGO experts, discussed data management actions that support increased use of participatory science data in decision-making.

In June 2022, EPA issued the vision for participatory science. It describes EPA's vision for the strategic use of participatory science approaches in EPA's work. It will help guide us in the use of participatory science in our

programs to increase the types and amount of data brought forth to inform scientific research, to enhance public engagement and understanding, and to take actions to investigate and mitigate environmental problems. In March 2023, EPA issued the Participatory Science Policy Guidelines and Checklist. This document identifies existing policies that may be relevant to participatory science activities within EPA, including topics such as working with communities, citizen science statutory authorities, information quality guidelines, formal agreements, and many other legal and administrative requirements. This year, EPA is working with the EELC to develop a strategy to improve the management and use of participatory science at EPA.

For more information visit:

- EPA's Participatory Science website
- StoryMap featuring examples of how EPA uses participatory science
- E-Enterprise webinar: Improving the Management and Use of Community Science Data

Partners: Environmental Council of the States (ECOS), Association of State and Territorial Health Officials (ASTHO)
Challenge: Protecting the public's health from environmental threats and hazards and advancing health and environmental equity for all
Resource: Tools, reports, workshops, and risk communication resources
Project Period: 2016 – Present

"ECOS values the relationships that we have built over the past five years with ASTHO and EPA as we have worked to address issues such as PFAS, lead, COVID-19, and wildfire smoke. With this amendment, we look forward to another five years of working towards our shared interests in advancing environmental and health equity for all citizens." – Patrick McDonnell, former Secretary, Pennsylvania Department of Environmental Protection and ECOS President

"ASTHO is pleased to continue this important partnership, recognizing that our nation's environmental policies have a direct impact on public health and equity. The collaboration supports ASTHO's challenge to build healthy and resilient communities through a multiyear, national effort to promote community-led, place-based, cross-sector approaches to achieve better health. Working closely with our state and federal environmental allies is paramount to helping meet this challenge." – ASTHO Health Security Vice President Meredith Allen, DrPH

EPA entered into a formal Memorandum of Agreement (MOA) with ECOS (the national association of state environmental agency leaders) and ASTHO (the national association of state and territorial chief health officials) in 2016. The purpose of the MOA is to advance our shared mission to protect the public's health from environmental threats and hazards and to advance health and environmental equity for all. At the ECOS Spring Meeting in March 2021, EPA Administrator Michael Regan reaffirmed the agency's commitment to working collaboratively and cooperatively with the states to protect public health and the environment. He announced the extension of this MOA in his keynote address, reaffirming a partnership between EPA, ECOS and ASTHO to advance cooperative initiatives in pursuit of environmental health.

Under the MOA, EPA will work with the coalitions to help develop tools, reports, workshops, meeting communications and other initiatives that will help protect public health from environmental threats.

During the past seven years, the MOA has served as a catalyst for EPA to work directly with environmental health experts in the states to identify emerging environmental health challenges, strategically design projects aimed directly at those challenges, and deliver the tools, models, and other research results that EPA and states need to reduce risks and improve public health. Example projects have targeted a wide range of environmental health challenges, including COVID-19, PFAS, harmful algal blooms (HABs), wildfire smoke, resiliency and complex disasters, and One Health.

See the below links to read the MOA and for more details on completed projects:

- EPA-ECOS-ASTHO Memorandum of Agreement (Amendment 1)
- Collaborative Projects with State Environmental Health Experts
- EPA-ECOS-ASTHO Annual Accomplishment Reports

COVID-19

Partner: University of North Carolina (UNC) Medical Center
Challenge: Urgent shortage of respirators caused by the emerging COVID-19 pandemic
Resource: Performance evaluation of sub-optimal and alternative respirators
Project Period: 2020 – 2022

"A true silver lining of the COVID pandemic is that it has created opportunities for scientists across different disciplines and backgrounds to work together to answer meaningful and practical questions with excellent science. Aerosol scientists from the US EPA and UNC Center for Environmental Medicine, Asthma, and Lung Biology worked closely with epidemiologists from UNC Hospitals to characterize the efficacy of face masks for reducing exposure to COVID-19. The EPA scientists were able to pivot quickly to address the needs of the Hospital because of the standing infrastructure and complementary expertise supported by the EPA-UNC Cooperative Agreement." – UNC-Chapel Hill Professor of Medicine William Bennett, PhD

"These kinds of studies exemplify the importance of the working relationship between academia and applied public health. This study will shed light on what has been one of the most challenging and disheartening aspects of the COVID pandemic. Comparative effectiveness of face coverings is an essential issue for our health care professionals and for the general public. And it is important to be clear that not everyone needs the same level of protection." – ASTHO Chief Medical Officer Marcus Plescia, MD MPH

In March 2020, UNC Hospital staff faced an urgent, acute shortage of disposable N95 respirators caused by a nationwide supply shortage coupled with a sharp increase in demand, the result of the emerging COVID 19 pandemic in the U.S. A broad variety of face coverings have been adopted, ranging from improvised and homemade designs to mass-produced disposable or reusable masks. However, little guidance or information exists on the comparative effectiveness of these face coverings.

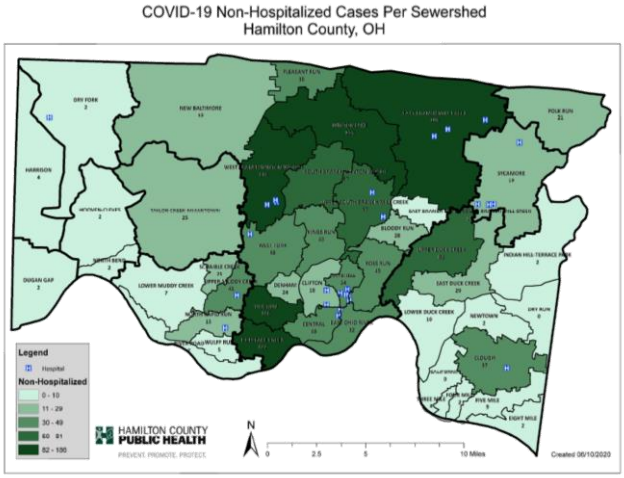
In response, hospital staff approached EPA researchers for assistance evaluating the performance of respirators that had been sterilized, were past their expiration date or mis-sized, as well as respirator alternatives from around the globe. In a series of studies, EPA ORD researchers evaluated nearly 30 different types of face coverings, as well as how their effectiveness was impacted by actions such as talking and bending, double masking, and by user characteristics such as facial hair.

This information can guide public health professionals in prioritizing the supply of available personal protective equipment during emergencies and will advance the understanding of factors and practices that influence the effectiveness of face coverings.

Related Publications:

- Filtration Efficiency of Hospital Face Mask Alternatives Available for Use During the COVID-19 Pandemic
- Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic
- A novel method for the quantitative assessment of the fitted containment efficiency of face coverings
- Can disposable masks be worn more than once?
- Improvement in Fitted Filtration Efficiency of N95 Respirators with Escalating Instruction of the Wearer
- Research Letter: Fitted Filtration Efficiency of Double Masking During the COVID-19 Pandemic
- Assessing the effect of beard hair lengths on face masks used as personal protective equipment during the COVID-19 pandemic

Partners: Ohio Department of Health (DOH); Ohio EPA; Ohio Water Resources Center; Cincinnati Municipal Sewer District (MSD); Pickaway Correctional Institute (Orient, OH); Hamilton County Public Health; Cities of Batavia, Dayton, Hamilton, Marion, Portsmouth, and Springfield (OH)
Challenge: Understanding community infection rate of SARS-CoV-2
Resource: Monitoring levels of SARS-CoV-2 in sewage to assess community infection rate
Project Period: 2020 – Present



"Our partnership with the US EPA has allowed us to broadly implement the innovative approach of collecting data from wastewater samples to prevent spread of COVID-19 across our state. Through this strong collaboration, we have been able to gain knowledge about the way the disease spreads, alert our communities about trends that could indicate cases are on the increase, help focus and prioritize testing and contact tracing resources, and serve as a model for other states." – Ohio Department of Health, Bureau of Environmental Health and Radiation Protection Assistant Chief Rebecca Fugitt

EPA researchers partnered with the state of Ohio on a project to better understand how sewer monitoring data can help them develop and evaluate a model on community infection rates for the presence of SARS-CoV-2 (the virus that causes COVID-19). In collaboration with Cincinnati MSD and Hamilton County Public Health, EPA researchers identified areas of high community infection rates and collected corresponding samples within the sewer network. These sub-sewersheds corresponded to the Hamilton County zip codes where there were noted increases in new cases of COVID-19. EPA researchers worked with the Hamilton County Public Health to compile known COVID-19 cases by sewersheds to identify monitoring sites and assist with relating the sewer signal to known infection rates in the community.

The initial pilot was later expanded into a state-level wastewater monitoring study, in collaboration with the Ohio Water Resources Center, Ohio EPA, and Ohio DOH. Network partners developed a list of sampling sites to capture Ohio's six major metropolitan areas, as well as approximately 40 smaller cities encompassing different counties and eight preparedness regions. EPA researchers focused on sampling sites from the southwest portion of the state, including Cincinnati, Dayton, Hamilton, Springfield, Batavia, and Portsmouth. Researchers analyzed and shared data with Ohio DOH for the new state wastewater surveillance dashboard, as part of the Ohio COVID-19 Dashboard. The state of Ohio will continue to sample until June 2021, and potentially longer. EPA researchers are continuing to develop partnerships within Ohio to analyze wastewater samples, allowing for comparison of sampling to health prevalence data. EPA researchers have also met with the states of Arkansas and North Carolina and the City of Burlington, VT, to discuss methodologies and best practices used in the Ohio monitoring pilot.

The emergence of more highly infectious types of the SARS-CoV-2 has raised interest in evaluating the wastewater RNA signal for an unbiased, inexpensive estimate of the diversity of SARS-CoV-2 variants circulating in the community. EPA researchers are developing plans to begin high-throughput sequencing of Ohio wastewater samples.

HABITAT

Partners: West Maui Ridge 2 Reef Initiative and U.S. Coral Reef Task Force
Challenge: Evaluating the use of the flocculant, chitosan, on Hawaiian stony corals
Resource: Laboratory research on Hawaiian corals
Project Period: 2020 – Present

"We are so excited EPA's research team is working with us on this project. Their results will finally give us the critical insight needed to potentially unlock a tool that can settle out fine sediment, a pollutant responsible for significant loss of coral in West Maui. If found safe, we can move forward with developing applications for chitosan's use and break through our current technical limitations in improving nearshore water quality." – West Maui Ridge 2 Reef Initiative Tova Callender

EPA scientists collect coral at Sugar Beach, Maui.

The U.S. Coral Reef Task Force (USCRTF) is a multi-agency workforce of federal agencies, states, territories, commonwealths, and Freely Associated States formed to preserve and protect coral reef ecosystems. Members meet regularly to address needs and priorities of regions and/or concerns of specific reef habitats. Hawai'i's West Maui Watershed was identified by the USCRTF as a priority watershed requiring mitigation and restoration efforts to reduce land-based sources of pollution.

EPA ORD has largely focused its research efforts on Atlantic/Caribbean coral reefs with little to no emphasis on Hawai'i or Pacific coral. Listening to the needs of partners, the challenge was bridging the gap between ORD research and local concerns for Pacific, specifically Hawaiian coral reefs that are not only of environmental and ecological importance but have significant cultural value to native Hawaiians.

ORD researchers, in collaboration with EPA Region 9 (Pacific Southwest), have taken steps to include investigations of Hawai'i corals in their current research. As of 2023, ORD now houses Hawaiian coral at the Gulf Ecosystem Measurement and Modeling Division's Coral Research Facility. Researchers there will expose Hawaiian corals to the flocculant chitosan to assess its impacts on growth. The results of the research will determine if the use of flocculant can be used in West Maui's watershed to be used as a management tool to reduce sediment exposure to West Maui's coral reefs.

The findings of this research will support West Maui's Ridge 2 Reef Initiative, a coalition dedicated to address adverse impacts to West Maui's coral reefs. The research outcome will provide guidance on possible solutions to significantly reduce sediment and improve water quality not only on West Maui's coral reefs but other reef habitats around the world.

Partner: Florida Department of Environmental Protection and Florida Keys National Marine Sanctuary
Challenge: Evaluating effects of microplastics on Atlantic stony corals
Resource: Research on impacts of microplastics on coral growth
Project Period: 2017 – Present

"NOAA Florida Keys National Marine Sanctuary is pleased to support ongoing research efforts by EPA into microplastics, as this critical work directly supports the sanctuary's goal to improve understanding and condition of sanctuary resources. Information gained from EPA's efforts will guide management decisions to reduce threats to sensitive resources, such as stony corals." – Joanne Delaney, Resource Protection and Permit Coordinator, CPC, Inc. in support of Florida Keys National Marine Sanctuary

Acropora cervicornis (staghorn coral) that has ingested orange microplastic.

Microplastics are small plastics (<5mm) that are found in all aquatic habitats. As they spend time in the water, a biofilm is created on the surface of the microplastic which can include micro-organisms and/or chemical pollutants. This biofilm decreases the buoyancy of the microplastic causing it to sink, where they can be ingested by corals—filter feeders that indiscriminately pluck tiny particles out of the water.

EPA researchers are conducting laboratory studies to determine the size of microplastics that corals can ingest and determine if microplastics are retained once ingested. Additionally, the researchers varied the time of microplastic exposures to determine the long- and short term effects on growth. Additional research was conducted by collecting coral and water samples from Florida's coral reef to determine the abundance of microplastics. Agency researchers continue to work to determine thresholds values which will not impact coral.

The results of the research have greatly improved our knowledge on how corals actively ingest microplastic. Though corals ingest a wide range of microplastic sizes, coral will also egest (spit out) the majority of microplastics ingested. Even though coral retain a small portion of microplastics, repeated ingestion could impact coral by blocking their digestion tract preventing coral from ingesting food. Additionally, the energy required to egest microplastics could lead to decreased growth rates and impact to reproduction. Not only do microplastics potential harm coral due to physical impacts, but hazardous biofilms could also expose coral to harmful pollutants.

Partner organizations can use the findings from this research to know the potential and actual risks of microplastics on coral. The data will also assist with determining potential sources of microplastic pollution. It is expected that partner organizations would use research findings to implement improved management applications to minimize microplastic exposure to coral.

Partner: Pensacola and Perdido Bays Estuary Program
Challenge: Monitoring the health of the estuary
Resource: Technical support for the development and implementation of a probabilistic monitoring framework
Project Period: 2020 – Present

Hidden Gems: One of the many waterways within Pensacola Bay and Perdido Bay estuaries where people can connect with nature.

"Completing an intensification of the Condition Assessment Survey within the Pensacola and Perdido Bay watersheds would not have been possible without the technical, field and facility support provided by EPA ORD's Gulf Ecosystem Measurement and Modeling Division (GEMMD). As a result, local natural resource management decisions are and will be informed by survey results. The Pensacola & Perdido Bays Estuary Program (PPBEP) is grateful for our partnership with ORD, and we look forward to continued collaboration in the years ahead." – PPBEP Executive Director Matt J. Posner

In 2018, EPA awarded Escambia County, Florida a $2-million cooperative agreement under the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies (RESTORE) of the Gulf Coast Act to establish the non-regulatory, place-based Pensacola and Perdido Bays Estuary Program (PPBEP). Through a coalition of local, state and federal stakeholders from two states, two watersheds, four counties and five municipalities, the PPBEP fosters partnerships and coordinates efforts to collaboratively achieve publicly identified goals and objectives to restore and conserve the environment and the economy of the Pensacola and Perdido Bay region.

To assist the PPBEP in implementing a coordinated long-term environmental monitoring program, EPA ORD researchers, in collaboration with the EPA Region 4 (Southeast), worked with the PPBEP team to develop and implement a probabilistic sampling strategy using protocols established under EPA's National Coastal Condition Assessment (NCCA). Water, sediment and fish measurements and samples were taken and analyzed for pollutant, toxicity, and biological characteristics. EPA staff provided the technical support for the survey design, training, field logistics and sample collection. The results produced from the 2021 sampling event will serve as a baseline for the PPBEP to monitor progress in restoring and maintaining the resilience of the Pensacola and Perdido Bays and the community benefits derived from healthy productive estuaries.

The 2021 PPBEP coastal assessment partnership team representing the Pensacola and Perdido Bays Estuary Program; EPA Gulf Breeze, FL and Region 4-Athens, GA; Escambia County, FL; Florida Fish and Wildlife Conservation Commission; and EPA Office of Water (not pictured).

Learn more about the Pensacola and Perdido Bays Estuary Program.

Partners: City of Superior (WI) Parks, Recreation, and Forestry; Wisconsin Department of Natural Resources (DNR); St. Louis River Area of Concern; Lake Superior National Estuarine Research Reserve; University of Minnesota-Duluth Natural Resources Research
Challenge: The contamination of Pickle Pond by runoff and invasive plants
Resource: EPA's Remediation to Restoration to Revitalization (R2R2R) approach to improve Pickle Pond for the benefit of the local community
Project Period: 2022 – Present

"Environmental stressors and restricted access have impacted public interests in the Pickle Pond for more than 130 years. The Wisconsin DNR is extremely grateful for the efforts of the ORD to evaluate the pond's ecological health and human connections to it before and after the construction of the restoration project. We are excited by the opportunity to see the restoration efforts bear fruit and the application of good science to evaluate changes in the condition and use of the site. EPA has been a great partner and their assistance in reaching the community through signs posted at the site and by hosting a website with project information and updates has played an important role in the success of this collaboration." – Wisconsin DNR Project Manager Joe Graham

The origin of Pickle Pond in Superior, Wisconsin dates back to the 1800s when a railroad construction project cut it off from the rest of Barker's Bay. Isolated and sheltered from the larger bay, it became a unique area in the lower estuary that provides a habitat to both native plants and wildlife. However, it did not endure as a healthy ecosystem. Over the years, contamination from diverted sewage and runoff from the increasingly urban surrounding watershed have significantly reduce the water quality of Pickle Pond.

Researchers from EPA's Great Lakes Toxicology and Exposure Laboratory study the benefits of coastal wetlands restoration in the urban Great Lakes Estuary, including Pickle Pond which is considered an Area of Concern. The studies revealed Pickle Pond provided an ideal opportunity to expand the EPA's understanding of how the local human community would respond to the restoration of a recreational coastal wetland area. It is the first of the Remediation to Restoration to Revitalization (R2R2R) projects planned which incorporates community engagement both pre- and post-restoration. Researchers have been and will continue conducting intercept surveys to understand how visitors' experiences at the site change during and after the project. In early 2022, EPA researchers began collaborating with the City of Superior and the Wisconsin Department of Natural Resources to design a project plan for restoration.

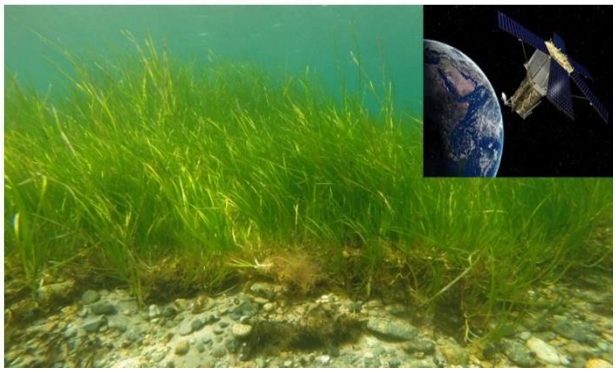
In May 2023, remediation actions started, beginning with dredging to remove contamination and deepen the pond to enhance the fish habitat. In addition, abandoned railroad tracks are being removed from the causeway to prevent continuing rust and other related contaminants from reaching the pond through runoff.

In addition to improving conditions for fish, the work will enhance the coastal habitat for native vegetation and improve connectivity between the pond and the St. Louis River Estuary. It is also projected that stormwater inputs to

the pond will be reduced and trails, water access, and wildlife/scenic viewing locations may be created, all either as part of the project or by partner organizations after the initial project is complete.

The R2R2R methods used in the Pickle Pond project will create benefits for local communities—both human and wildlife—with direct links to the river estuary. What the research team and their partners learn will also inform future planning efforts and improve the evaluation of project goals for future restoration projects in the St. Louis River Estuary.

Partner: Connecticut Department of Energy and Environmental Protection
Challenge: Developing a cost-effective technique to more frequently map seagrass resources in estuaries using standard aerial photography, especially for states with large coastlines
Resource: Investigating the efficacy of using high-resolution satellite imagery as a tool to map seagrass distribution and condition in estuaries along the southern New England coastline
Project Period: 2018 – 2019



"By working together to improve remote sensing of eelgrass, EPA and Connecticut DEEP will better be able to develop and measure the success of strategies to protect and restore this important resource. Eelgrass is critical to the ecological health of the Niantic River Estuary and ultimately the Long Island Sound." – Connecticut Department of Energy and Environmental Protection, Deputy Commissioner for Environmental Quality Betsey Wingfield

Seagrass is a critical marine habitat that serves as nursery habitat for many fish species. It also sequesters carbon, serving as an important buffer to climate change. To conserve this important resource, it is necessary to have accurate and timely maps of seagrass distribution and condition. The most common method to generate distribution maps is with low altitude aerial photography. Seagrass condition is assessed by field collection of plants. For states with extensive coastlines, these assessments quickly become cost prohibitive.

During the summers of 2018 and 2019, EPA ORD, in collaboration with EPA Region 1 (New England) and Region 2, and Dominion Energy, successfully developed algorithms to estimate seagrass distribution, abundance and condition in the Niantic River estuary in eastern Connecticut using high resolution (30 m) imagery from the Landsat 8 satellite. Additionally, EPA ORD scientists used vegetation and water column samples collected from the Niantic River estuary to develop and validate algorithms to estimate presence, abundance, and condition of seagrass from satellite images. The algorithm was then verified using vegetation collected by the EPA Region 1 Dive Team. In situ optical and water samples were collected by ORD researchers.

The successful use of remote sensing methods to map seagrass will provide federal and state natural resource managers a set of tools to efficiently generate large-scale estimates of seagrass distribution, abundance, and condition. More frequent and timely data collection will provide natural resource officials with better information upon which to base management and conservation of this important natural resource.

Partner: Connecticut Agricultural Experiment Station (New Haven, CT)
Challenge: Protecting New England bees from potential impacts of exposures to pesticides used in plant nurseries
Resource: Case studies characterizing potential hazards to bees associated with the consumption of pesticide contaminated pollen
Project Period: 2017 – 2020

"This collaborative research project with the US EPA allowed us to continue and expand the research of the Connecticut Agricultural Experiment Station with the ornamental nursery industry in Connecticut – the largest agricultural industry by value in the state, and one of the largest in the region. Through this research, we have been able to quantify levels of exposure of honey bees to pesticides in pollen under realistic nursery conditions, and to identify insecticides such as acetamiprid that are not likely to pose a hazard to bee health at the levels of exposure we have found in the field." – Connecticut Agricultural Experiment Station Entomologist Kimberly Stoner, PhD

EPA Region 1 (New England) has identified the protection of bees and other pollinators from pesticide risk as a regional research priority. The area is home to a thriving horticulture industry, including large plant nurseries and greenhouse operations. Currently, there is little data on how pesticide use in these operations might impact local bee populations.

To address this knowledge gap, EPA ORD researchers, in collaboration with EPA Region 1, partnered with the Connecticut Agricultural Experiment Station in New Haven, CT, to design studies to provide information on: 1) the types and quantities of pesticides found in pollen harvested by honey bees in New England plant nurseries, 2) the types of plants that honey bees forage on in New England plant nurseries, and 3) the effects that chronic dietary exposure of the pesticide acetamiprid (a neonicotinoid purported to be less toxic to bees) has on bumble bee microcolony development and productivity under laboratory conditions. Bumble bees are under-studied and little information is available about the effects of exposure to acetamiprid on these bees.

Research results to date suggest that neonicotinoids play a smaller role in the toxicity associated with the contaminated pollen than initially anticipated. Additionally, there is evidence that chronic dietary exposure to acetamiprid has the potential to impact bumble bee microcolony development and productivity, but only at concentrations higher than environmental concentrations that would be achieved when following label rates. Additional studies conducted under field conditions are necessary to better understand the potential consequences of exposure to acetamiprid on bumble bees.

Partner: Hawaii Department of Land and Natural Resources (DLNR)
Challenge: Restore and enhance the health and resiliency of West Maui coral reefs
Resources: Adaptation Design Tool and Manager's Guide to Coral Reef Restoration Planning and Design
Project Period: 2017 – Present

"Participating in the development of the CCAP Adaptive Design Tool has given the West Maui watershed planning team an opportunity to engage in in-depth conversations with experts from around the world about how climate change is likely to impact coral reef health and the connecting watersheds. Once the tool is finished, we anticipate incorporating the framework into our decision making to arrive at the most resilient set of watershed management strategies that are relevant into an uncertain future." – Hawaii DLNR Watershed Coordinator Tova Callender

The West Maui Ridge to Reef (R2R) initiative, founded by Hawaii DLNR, addresses adverse impacts to coral reefs in West Maui. It takes a comprehensive, watershed-based approach to reducing land-based sources of pollution as a critical step toward restoring and building the resiliency of coral reef ecosystems. However, climate change is complicating that effort. Increasing temperatures and ocean acidification directly impact the health of coral reefs. In addition, changing precipitation patterns are altering the frequency and load of nutrient pollution reaching coastal waters through runoff. Managers need tools that incorporate climate change information and scenarios.

EPA ORD worked with the R2R Initiative on climate-smart management planning through a cooperative effort of the Climate Change Working Group of the Interagency U.S. Coral Reef Task Force led by EPA. To achieve the creation of effective, place-based adaptation actions using recent adaptation planning principles and frameworks, the Task Force and R2R teams collaborated through workshops, webinars, and expert consultations to develop the Adaptation Design Tool. This tool guides users through activities to: 1) systematically analyze a series of design considerations for adjusting existing management actions to be more climate-smart; and 2) brainstorm and tailor additional adaptation actions based on general strategies compiled from the literature. EPA ORD continued to work with the state of Hawaii as part of an interagency collaborative effort to create and test *A Manager's Guide to Coral Reef Restoration Planning and Design*. The Guide incorporates key elements of climate-smart adaptation based on the Adaptation Design Tool and aids users in a stepwise process to set goals, select sites, identify, and design climate-smart restoration interventions, and assemble an action plan. A new supplement to the Guide, *Action Plan for Restoration of Coral Reef Coastal Protection Services: Case Study Example and Workbook*, demonstrates how to use the Guide by presenting a hypothetical coral reef restoration project located in the Pacific region with a focus on the goal of improving the ecosystem service of coastal protection. It supports Guide users by (1) demonstrating the type of information that can be usefully compiled in the workbook and converted into an action plan, (2) presenting the current state of knowledge relevant to a coastal protection goal, and (3) helping to inspire ideas of appropriate parallel information to fill in for other goals, reef locations, and management contexts. Hawaii is one of four Pacific jurisdictions that have been first to complete an action plan based on the Guide.

Trainings on the Adaptation Design Tool and the Restoration Guide are available on the Reef Resilience Network webpage.

Partner: Escambia County (Florida) Natural Resources Management Department, Water Quality and Land Management Division
Challenge: Evaluating sediment habitat quality in an urban estuary to inform sediment remediation activities
Resource: Technical support to assess sediment habitat quality using novel remote sensing technologies
Project Period: 2019 – Present

"Bayou Chico has long supported commerce and industry in the greater Pensacola area with many examples dating back over 150 years. Among other goals, the Bayou Chico Sediment Remediation Project seeks to restore fish and wildlife habitat within the bayou. Escambia County has recently partnered with EPA ORD to document existing conditions within the Bayou Chico benthic community. Not only did the survey allow for rapid collection of the ecological information needed to support the sediment remediation project, but it also provided a great opportunity for EPA researchers to gain valuable information about the performance of the SPI (Sediment Profile Imaging) equipment within the mucky bayou sediments. EPA's presence here along the northern Gulf Coast continues to be big factor in furthering our understanding of the Pensacola and Perdido Bay estuaries. We look forward to a continued partnership with EPA working to restore Bayou Chico, and hopefully many more projects to come." – Escambia County Natural Resources Management Department, Water Quality & Land Management Division Brent Wipf

Bayou Chico in Escambia County, Florida, is an urban estuary considered one of the most historically contaminated water bodies in the state. Despite recent efforts to improve surface water quality, sediments remain impacted by fecal coliform bacteria, excess nutrients, and legacy contaminants, including heavy metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs). Escambia County is developing a sediment remediation plan for Bayou Chico. Understanding the distribution of soft sediments and benthic (bottom) habitat condition will assist the County in these planning activities.

EPA ORD scientists, in collaboration with EPA Region 4 Gulf of Mexico Division, deployed the Sediment Profile Imaging (SPI) camera system in Bayou Chico in December 2019. The SPI system is a rapid sampling technology that captures images of cross-sectional views of the sediment—both water interface and subsurface features. These images are used to make qualitative and quantitative measurements on the biological, chemical, and physical character of sediments. Escambia County identified over 30 stations scattered throughout the Bayou to be surveyed. Image analysis is now underway. Sediment and biological features that can be identified in the imagery will be evaluated to identify possible relationships between these measures and known stress gradients in the Bayou.

In addition to evaluating the Bayou's benthic habitat quality, this collaborative work provided researchers the opportunity to test the effectiveness of recent modifications to the SPI camera frame to accommodate sampling in soft sediments. This ultimately improves ORD's scientific capabilities in the future. An understanding of current sediment habitat characteristics and benthic habitat condition through this SPI assessment will assist the County in planning for sediment remediation and restoration activities in Bayou Chico.

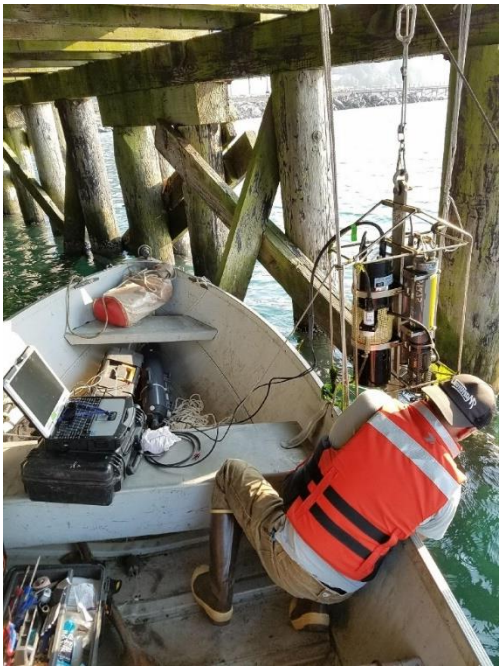
Partners: Florida Department of Environmental Protection (DEP), South Florida Water Management District (SFWMD)
Challenge: Saltwater encroachment damaging freshwater vegetation communities in the floodplain
Resource: Time series salinity model as a tool for development and evaluation of restoration alternatives
Project Period: 2017 – 2019

"The salinity tool will allow the ecological sub-team of the Loxahatchee River Watershed Restoration Project to evaluate the various potential project features in order to determine what grouping of features such as storage reservoirs, storm water treatment facilities, and restored wetlands performs the best for the restoration of flows to the federally designated Northwest Fork of the Loxahatchee River. The tool allows us to take the differing flow scenarios from the watershed and predict how those flows will change the salinity regimes in the river and therefore affect the location, health and survival of key indicator species such as juvenile fish, submerged aquatic vegetation and oysters." – SFWMD Applied Science Bureau, Coastal Ecosystems Section Science Supervisor Patti Gorman

Loxahatchee River contains a diverse array of aquatic and riparian ecosystems, with the upper reach being home to one of the last remnants of bald cypress (*Taxodium distichum*) floodplain swamp in southeast Florida. In 1985, a 16.6-km stretch of the river became Florida's first federally designated National Wild and Scenic River. The unique ecosystem of the Loxahatchee River, with its quiet beauty, has captured the attention and imagination of residents and visitors, as well as agency and community leaders for many years. However, anthropogenic alterations of the Loxahatchee River watershed, particularly the permanent opening of the Jupiter Inlet and construction of drainage canals, have resulted in significant encroachment of a saltwater- tolerant, mangrove-dominated community into the freshwater floodplain currently dominated by bald cypress. Restoration of the ecosystem has become a priority for federal, state and local agencies and the general public.

Essential to the restoration of the Loxahatchee River ecosystem are technically sound modeling tools for the development and screening of restoration alternatives. EPA ORD scientists developed a salinity modeling tool implemented in a user-friendly Excel© platform. Salinity can be simulated with a given time series of freshwater inflow associated with varying restoration alternatives developed during the planning process. Spatial features of the tool also allow for estimation of salinities at any designated locations along the entire reach of the river. The simulated salinity data are further used to quantify the ecological benefits with respect to habit lifts of freshwater floodplain vegetation, fish larvae, oysters and seagrasses in response to these varying restoration alternatives. Stakeholders from the SFWMD and Florida DEP are using this tool in the development of restoration alternatives, while EPA ORD scientists continue to provide technical support for model development and application.

Partners: Oregon Department of Environmental Quality and Tillamook Estuaries Partnership (TEP)
Challenge: Acidification in estuaries threatening shellfish fisheries
Resource: Providing science to support the states in assessing impacts of coastal acidification
Project Period: 2017 – Present



"ORD scientists have collaborated with TEP and local partners to address global issues like [Ocean Acidification and Hypoxia] at a local level, making our communities and economies less vulnerable to future challenges and changes. Together, we are working to protect species that rely on the estuaries for their survival, including oysters, Dungeness crabs and threatened coho salmon." – Tillamook Estuaries Partnership Executive Director Dr. Kristi Foster

Increasing acidification of offshore ocean waters is threatening recreational and commercial fisheries. Governors of California, Oregon and Washington have joined with stakeholders (state, tribal, federal, watershed councils, the aquaculture industry, and universities) through the Pacific Coast Collaborative to develop coordinated solutions to address the adverse effects of ocean acidification. In Oregon, the Oregon Coast Ocean Acidification and Hypoxia Workgroup formed to advance recommendations from the Collaborative. Oregon DEQ invited EPA scientists to be members of the Ocean Acidification and Hypoxia Technical Workgroup. The workgroup is assisting Oregon DEQ to develop ocean acidification and marine dissolved oxygen assessment methodologies for future Clean Water Act integrated reports.

In addition to participating in the interagency workgroups, EPA scientists are conducting research on how excess nutrients contribute to the acidification of estuarine waters. They are exploring the use of seagrass meadows as a resource to help reduce the effects of acidification to shellfish and developing a coastal acidification indicator for the National Coastal Condition Assessment. Since 2017, Agency scientists, in collaboration with the Tillamook Estuaries Partnership, have been monitoring coastal acidification in the Tillamook Estuary. Data from the monitoring effort have already contributed to two publications: 1) a paper comparing coastal acidification across National Estuary Program sites and (2) an EPA report focused on challenges and solutions associated with monitoring acidification in estuaries. The research is being conducted at EPA's Pacific Coastal Ecology Laboratory in Newport, OR and in Tillamook Bay—the site of Oregon's largest inshore shellfisheries. The results of this research will provide state agencies with tools to reduce the causes and effects of acidification in Pacific Northwest estuaries, thereby enhancing the environment and economies that depend on the shellfisheries.

Partner: Washington State Department of Ecology
Challenge: Understanding causes of change in nearshore ecosystems in Puget Sound
Resource: Projecting species vulnerability to changes in sea level, water temperature and coastal acidification with the Coastal Biodiversity Risk Analysis Tool (CBRAT)
Project Period: 2016 – 2018

"The work EPA is doing through CBRAT will provide essential knowledge on how climate change may impact the benthic community and inform how we clean up contaminated sediment sites and restore habitat to improve the health of Puget Sound." – Washington State Department of Ecology, Toxic Cleanup Program Chance Asher

Since the 1980s, the Washington State Department of Ecology has monitored seafloor condition as an indicator of the health of Puget Sound nearshore ecosystems. Sediment chemistry, toxicity, and benthic invertebrate community structure are monitored annually to determine whether sediment-bound chemical contaminants, water quality, or other stressors have affected the composition of seafloor communities. Findings indicate declining quality of Puget Sound seafloor ecosystem condition; however, in many locations, changes do not appear to correspond with sediment contaminant concentrations. Consequently, Washington Department of Ecology investigated which non-contaminant stressors may be causing this decline, including increased carbon and nutrient loading, alteration of biogeochemical processes, and climate change.

Washington Department of Ecology requested information from EPA ORD scientists using the Coastal Biodiversity Risk Analysis Tool (CBRAT) to determine whether climate-related stressors may be contributing to observed declines and to predict which stressors may be drivers in the future. The CBRAT is a web-based tool that projects the risk that invertebrates and fish face due to changes in sea level, water temperature and nearshore ocean acidification based on the species' distribution, abundance, life history, and environmental tolerances.

Washington Department of Ecology and EPA have used environmental and life history traits information from the development of CBRAT to assess which Puget Sound seafloor invertebrates are most vulnerable to changing nearshore conditions. Those results can help inform the state about whether climate variables may have contributed to recent changes in seafloor communities and to help forecast the composition of those communities under future near-shore climate scenarios.

Future efforts will focus on peer-reviewing and publishing the underlying data in CBRAT.

More information on the Coastal Biodiversity Risk Analysis Tool.

Partner: Washington State Department of Natural Resources (DNR)
Challenge: Selecting sites for restoration of native seagrass beds and managing invasive species
Resource: Habitat suitability models for native and invasive seagrasses in collaboration with the U.S. Army Corps of Engineers
Project Period: 2016 – 2018

"The eelgrass biomass production model, developed by EPA ORD's Newport lab, is a critical module in the eelgrass site selection model. A multi-faceted team of state, federal and private sector scientists integrated an existing Puget Sound coupled physical and biogeochemical model with the eelgrass biomass production model to identify sites where the biomass of transplanted eelgrass would increase over time. Knowledge of these parameters vastly improve eelgrass restoration site selection and transplant success."
– Washington State DNR, Aquatic Biologist Jeffrey Gaeckle, Ph.D.

Seagrass meadows are valued by coastal communities and tribes as nursery habitats for fisheries species (e.g., Dungeness crabs, bay clams, Chinook and Coho salmon) and habitat for many of forage species that support fisheries and wildlife in the Pacific bays and estuaries. Washington had a goal to increase the area of native seagrass beds in the Puget Sound by 20 percent by the year 2020, requiring knowledge of where restoration and habitat conservation efforts will be most successful. Washington State DNR, working with the Pacific Northwest National Laboratory as part of the Puget Sound Partnership, has been using EPA ORD research on seagrass physiology to help identify locations where native seagrass (*Zostera marina*) are likely to thrive. These sites were then prioritized for further assessment and the potential for seagrass restoration. Sites with favorable environmental conditions based on model output are more likely to be successfully restored with eelgrass.

In Washington, Japanese eelgrass has been identified by the shellfish aquaculture industry as a noxious weed that disrupts the growth and harvest of Manila clams. Researchers from ORD have also been conducting research on the ecology of Japanese eelgrass and developed a habitat suitability model to determine where this invasive species has the potential to become established. Knowing where the invasive seagrass is likely to colonize can assist aquaculture biologists in developing efficient surveillance and eradication plans.

Additional resources:

- Eelgrass (Zostera marina L.) Restoration in Puget Sound: Development of a Site Suitability Assessment Process (published 2019)
- Development and validation of a habitat suitability model for the non-indigenous seagrass Zostera japonica in North America (published 2016)

Partners: Washington State Department of Ecology, Nooksack Indian Tribe, Lummi Nation
Challenge: Anticipating stream temperature stress on cold water fishes (salmon) in the Northwest
Resource: Long-term outlook models for rising stream temperatures to determine potential impacts of elevated temperatures and to examine potential mitigation strategies, in collaboration with the University of Washington, the U.S. Forest Service, NOAA Fisheries and U.S. Geological Survey
Project Period: 2012 – 2016

"Increased temperature and habitat degradation are a major threat to the many types of fish that live in this watershed. Through the process of research and data collection, we learned we must do everything we can to keep water quality conditions stable over the next few decades. We never would have had the ability to look into the future without the help of ORD." – Washington State Department of Ecology, Water Quality Engineer Steven Hood

Stream temperatures in the Pacific Northwest are projected to increase under future long-term weather scenarios due in part to increases in air temperature and in part to changes in water levels and water flow caused by altered rain and snowmelt patterns. Combined, these changes in stream temperature and hydrology could have substantial negative effects on cold-water fish species such as salmon**.** To better understand the potential impact of long-term weather changes on the potential to achieve water quality and salmon recovery goals, EPA ORD, in collaboration with Region 10 (Pacific Northwest) and the Office of Water, launched a collaborative research project in the South Fork Nooksack River with the Washington State Department of Ecology.

The research plan incorporates the total maximum daily load (TMDL) for temperature, which was developed by the Washington State Department of Ecology for the South Fork Nooksack River, as a pilot for integrating future weather scenarios into a watershed-specific plan to improve water quality for cold-water fish species. An overarching goal is to ensure that relevant findings and methodologies related to future stream temperature scenarios inform the South Fork Nooksack River Temperature TMDL Implementation Plan under development by EPA Region 10 (Pacific Northwest) and the state of Washington.

Read the final report titled *EPA Region 10 Climate Change and TMDL Pilot – South Fork Nooksack River, Washington*.

Partners: Maryland Department of Natural Resources (MDDNR), West Virginia Division of Natural Resources (WVDNR), California Department of Fish and Wildlife (CADFW), California Department of Water Resources (CADWR), California State Water Reclamation Control Board (CASWRCB)
Challenge: Accurate methods to detect hard-to-find endangered species
Resource: Environmental DNA (eDNA) for inventory and monitoring of imperiled species in collaboration with the U.S. Fish and Wildlife Service (USFWS) Pennsylvania Field Office, and the University of Kentucky Department of Forestry
Project Period: 2017 – Present

"The development and validation of the eDNA methodology will profoundly change how aquatic populations are monitored and significantly improve the ability to conserve and recover rare aquatic species." – WVDNR Wildlife Diversity Biologist Janet Clayton

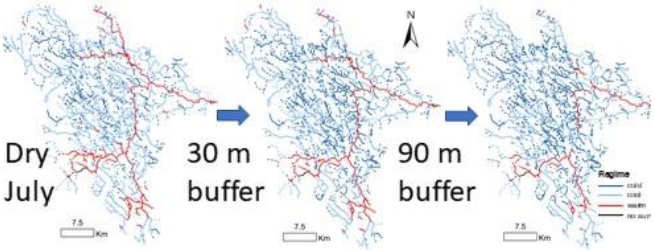
Conservation and management of endangered species requires being able to locate populations and determine their distribution in the environment. However, classical monitoring approaches may overlook or underestimate species presence. Because living organisms constantly shed DNA into the environment, environmental DNA (eDNA) may offer an efficient and non-invasive solution for detecting sensitive species at low abundances and can be readily obtained from environmental samples (e.g., water, soil) instead of thru capture of whole organisms. Because each organism's DNA contains a unique genetic code, eDNA can be used for precise taxonomic identification. The non-invasive nature of eDNA surveillance reduces stress, harm, and spread of disease to the species of interest.

To provide support to various state agencies and in collaboration with EPA Region 3 (Mid-Atlantic), EPA Region 9 (Pacific Southwest), the U.S. Fish and Wildlife Service (USFWS) Pennsylvania Field Office, and the University of Kentucky Department of Forestry, ORD scientist developed eDNA tools and assessed the capability of eDNA to determine distribution and relative abundance of species of concern. This included the federally-listed dwarf wedgemussel (*Alasmidonta heterodon*) within the Chesapeake and Potomac drainage basins in Maryland. Ongoing research is targeting multiple salamander species in KY streams, several imperiled freshwater mussels (Northern riffleshell, Snuffbox, Brook and Green floaters) in WV, PA, and MD; and listed species in the Sacramento river (Delta smelt) and Vernal pools (Fairy shrimp) in the Central Valley, CA.

These studies demonstrate how eDNA can be an effective tool for determining species occupancy at low abundances or limited biomass. For example, dwarf wedgemussel eDNA was detected in water samples from all Maryland streams known to support the species including streams with relatively low abundanc*es.* Innovative techniques like eDNA surveillance can be incorporated into the species conservation management toolbox as an efficient and cost-effective means for state agencies to inventory and monitor imperiled species occupancy, to guide more localized traditional monitoring efforts, and to inform habitat suitability studies for species reintroduction programs.

Partner: Houlton Band of Maliseet Tribe (Maine/New Brunswick)
Challenge: Identifying cold water refuge areas for brook trout and Atlantic salmon in the Meduxnekeag subwatershed on the Maine/New Brunswick border, as well as potential restoration actions to improve coldwater habitat
Resource: A fine-resolution spatial statistical (SSN) stream temperature model and an evaluation of the coldwater refuge distribution
Project Period: 2019 – 2020

"EPA ORD's temperature modeling for the Meduxnekeag watershed has been eye opening, both for our understanding of the potential impacts of climate change on our goal of restoring and sustaining cold water fisheries and migratory fish and for identifying opportunities to mitigate those impacts in a strategic and targeted way. This understanding has helped us prioritize next steps, like our ongoing effort to find ways to work with farmers in the watershed on increasing riparian buffers in active farmland." – Houlton Band of Maliseet Indians, Environmental Planner Sharri Venno



An international memorandum of understanding is in place between the Maliseet Tribe and the U.S. and Canadian federal governments with a goal of supporting habitat restoration in the transboundary Wolastoq (Saint John River) watershed for coldwater fisheries. A primary concern are Atlantic salmon populations, which are severely threatened overall and extirpated in portions of the watershed. Protection and restoration of habitat for coldwater fisheries requires knowledge of the distribution of thermal regimes within the watershed during the hottest portion of the summer with low baseflows.

In response to a request for technical assistance from the Maliseet, EPA researchers worked with the tribe to develop a fine resolution stream temperature model for the Meduxnekeag subwatershed that could be used to evaluate how the distribution of coldwater habitat varied between wet and dry years and simulate the effects of restoring riparian buffers. The model indicated that the mainstem of the Meduxnekeag provides only warm water habitat during July to August and that headwater tributaries are critical for providing cool- and cold-water habitat during times of thermal stress. The fraction of cool- and coldwater stream reaches could be expanded by restoring forested riparian buffers, with greatest benefit achieved with 30-meter width buffers as compared to wider buffers. During extremely dry years, little coldwater habitat remains and additional instream restoration practices may be required for mitigation. The Maliseet Tribe is using these results to guide their restoration activities in the Meduxnekeag and to support grant applications for those activities. Results have been published and shared with the Meduxnekeag working group coordinated by EPA Region 1 (New England) and composed of tribal, US and Canadian federal and provincial agencies.

HOMELAND SECURITY

Partner: Kentucky Department for Environmental Protection, Division of Water and Department of Public Health
Challenge: Providing clean, safe water following natural disasters
Resource: Water-On-Wheels Mobile Emergency Water Treatment System (WOW Cart)
Project Period: 2020 – Present

"Water everywhere and non-drinkable. During the 2022 Eastern Kentucky flooding event, the WOW carts provided crucial relief for first responders and residents during this horrific event." – KY Dept. of Health Readiness Response Coordinator David Carney

Recovery following a natural or man-made disaster such as a flood or accident often requires an emergency supply of safe, potable water. Bottled water is typically the first choice. However, long-term dependence on bottled water creates plastic bottle waste and in large or extended recoveries, using bottled water for bathing, sanitation and laundry is impractical. Mobile water treatment can significantly reduce the volume and cost of water to be transported.

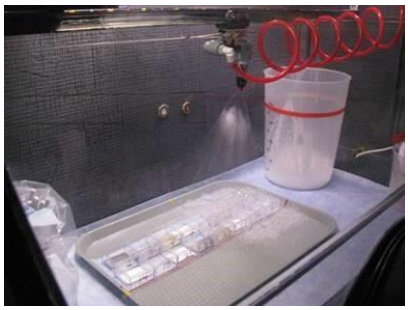
EPA ORD, in partnership with WaterStep, developed and patented the affordable and versatile Water-On-Wheels Mobile Emergency Water Treatment System (WOW Cart). The system is about the size of a shopping cart, is configured with multiple treatment technologies (filtration, carbon, UV and chlorination), can run on a variety of power sources (AC, DC and solar), and makes liquid bleach on site. The easy-to-operate technology makes quick training of first responders, community leaders, water system operators, and volunteer organizations possible, and it can be dispatched ahead of predicted natural events to facilities such as hospitals.

The WOW Cart has already been successfully used to help Kentucky communities in the aftermath of disaster:

- In December 2021, a deadly tornado devastated communities in Western Kentucky, knocking out power for days and placing thousands of customers served by the water utility under a Boil Water Order. A WOW Cart was set-up at the Graves County Health Department, in conjunction with the Kentucky Department of Public Health, to provide first responders with showers and safe drinking water. A second WOW Cart supplied safe water to a food relief organization that prepared thousands of free meals each day that were distributed from a mobile kitchen.
- In August 2022, deadly flooding occurred in Eastern Kentucky and the public water supply was lost for weeks. Working with state agencies, WaterStep and the Kentucky Rural Water Association were able to set up four WOW carts in the communities of Hazard, Buckhorn and Mayking. The WOW Carts supplied potable water and disinfectant for food facilities, mobile showers, laundry trucks, and displaced people.

Efforts are underway to pre-position up to 18 WOW Carts across the state of Kentucky, through an emergency response network of trained water system operators, engineers and volunteers. WaterStep is in discussions with the state of Kentucky to develop pre-approval for emergency mobile water treatment systems and the testing and monitoring requirements to assure the water is safe to drink.

Partners: Indiana State Department of Health; Massachusetts Department of Environmental Protection and Massachusetts Department of Fire Services; Michigan Department of Health and Human Services, Michigan State Police Forensic Science Division and Western Wayne County (MI) Hazmat Team
Challenge: Remediation of indoor fentanyl contamination
Resource: Decontaminant testing to effectively degrade fentanyl and its analogs
Project Period: 2020 – Present



"EPA's Office of Research and Development's (ORD) bench-scale fentanyl decontamination research on surface decontamination options and personal protective gear decontamination will help the Michigan Department of Health and Human Services (MDHHS) develop Clandestine Drug Lab Cleanup Guidance for fentanyl. The ORD research also helps MDHHS understand by-products that may be formed as a result of degradation of fentanyl during the surface decontamination process. The ORD research team has been a valuable resource and continues to assist the MDHHS team as we make informed, science-based decisions and assess decontamination approaches." – MDHHS Environmental Assessment and ATSDR Unit Manager Andrea Keatley

Fentanyl, a drug typically used in healthcare settings to manage pain, has been increasingly used illegally to enhance other opioid drugs due to its inexpensive production cost and higher potency. As the popularity of fentanyl rises, so does the potential for contamination of indoor environments, which poses exposure risks to first responders. In most cases, a lack of awareness of the need and methods to decontaminate premises where fentanyl was found presents risks for re-entry or re-occupancy.

To address this challenge, EPA developed a fact sheet in 2018 that provides local, state and county hazmat partners with the most pertinent information needed for a safe response to opioid contaminated sites. In 2019, EPA ORD researchers, with input from regional on-scene coordinators, tested multiple off-the-shelf, easy-to-access products for their ability to decontaminate fentanyl and its analogs, including on multiple common materials found in buildings such as glass, laminate and wood. Results show the best methods to be a spray application of several decontamination solutions—peracetic acid, hydrogen peroxide, and pH adjusted solution containing hypochlorite—followed by a one-hour contact time.

Additionally, EPA ORD studied methods for cleaning personal protective equipment (PPE), such as Tyvek suits, hazmat suits, firefighter turnout gear, and neoprene gloves, worn by first responders. Decontamination of these materials needs to occur in a shorter timeframe, only 1-5 minutes, as compared to the materials in the home. Research showed that solutions containing peracetic acid are highly effective in degrading fentanyl in only a couple of minutes. This initial research will be used to scale up efforts to address a larger scale decontamination application and establishing effective operational procedures that will minimize additional hazards. Further research will also address materials that are more difficult to decontaminate, such as those that are porous, and fumigation methods for more complex contamination scenarios.

Results of this research will inform federal, state, tribal and local agencies on the requirements for safely entering, decontaminating, and eventually clearing indoor environments contaminated with fentanyl. A report summarizing decontamination testing conditions, efficacies and protocols will be developed for responders in the field.

Partners: New York City (NYC) Department of Health and Mental Hygiene (DOHMH) and NYC Transit
Challenge: The ability to effectively identify and map contaminated areas following a large biological incident within a highly urbanized area in the U.S.
Resource: Technical assistance to evaluate the compatibility of current surface sampling options and analytical methods for *Bacillus anthracis* in an urban environment
Project Period: 2017 – 2019

"The instant that a biological threat agent incident has been detected, incident commanders will depend on and expect accurate and reliable incident characterization to support informed public health decision making. EPA's groundbreaking efforts in this regard will prove critical to New York City's ability to determine the scale and scope of biological incidents rapidly and efficiently." – NYC DOHMH Bioterrorism Surveillance Coordinator Joel Ackelsberg, MD, MPH

EPA researchers have worked collaboratively with NYC DOHMH and NYC Transit to answer key gaps in capabilities to conduct effective sampling operations following a large biological incident within a highly urbanized area. EPA researchers, in collaboration with these partners, evaluated the compatibility of current surface sampling options, when applied to urbanized outdoor or underground (subway) surfaces, with current analytical methods for *Bacillus anthracis*. EPA researchers and NYC DOHMHC have also worked collaboratively to determine the potential utility of "Native Air Sampling" approaches, and their compatibility with analysis methods.

Because of this federal-local partnership, NYC personnel actively participate in project update teleconference meetings and provide critical input into the project's directions. In this way, NYC has access to research outcomes as they develop, and NYC has ensured that the project meets the city's emergency response needs. Ultimately, the project has resulted in an enhanced ability to conduct sampling and analysis operations for a large urban area following a *Bacillus anthracis* contamination incident.

Partner: North Carolina Department of Agriculture and Consumer Services (NCDA&CS)
Challenge: Disposal of contaminated animal carcasses following an agricultural emergency
Resource: A prototype transportable gasifier technology for on-farm disposal of animal carcasses
Project Period: 2014 – 2016

"EPA has served as the coordination point for both the research and the response efforts related to mass disposal. Actual event response and field testing identify real problems that cannot be properly identified or solved when designing or modeling in an office. Environment, material handling, human factors, size and volumes of actual events must be experienced not perceived. EPA understands these challenges and continues to assist states and industry in attempting to solve the problems and bring workable technologies. Continued research and development efforts of this type are critical to assisting industry in their efforts to protect the food chain." – NCDA&CS Jim Howard (retired)

Agricultural emergencies, such as foreign animal disease outbreaks, could result in the need to dispose of many contaminated animal carcasses. The environmental impacts of carcass disposal are site-specific. Some technologies (e.g., burial) are not viable in areas with a high-water table, such as North Carolina. Multiple disposal options are necessary. Gasification has the potential to be a technology for on-farm use, which reduces risk associated with transporting the carcasses to an off-site location (e.g., landfill, incinerator). It also has the potential to generate energy at agricultural sites during non-emergency times, and burns more cleanly thus requiring less pollution control equipment than conventional incineration.

As part of an interagency effort involving several federal agencies and the state of North Carolina, EPA built a prototype transportable gasifier intended to process 25 tons per day of carcasses (scalable to 200 tons per day) for on-farm disposal of animal carcasses. A demonstration was conducted to determine the feasibility of gasification for carcass disposal and to identify technical challenges and improvements to simplify and improve the gasifier as a mobile response tool. Past testing of the prototype demonstrated partial success, in that the transportability and rapid deployment requirements were met; however, the throughput of animal carcasses was approximately one-third of the intended capacity.

Significant modifications were made to various gasifier components, including the burner system, feed system, control system, power distribution and ash handling system, in order to increase its operating capacity to the rated design throughput. In September 2015, a series of tests were performed to evaluate the effectiveness of the design modifications at increasing the system's throughput, as well as to demonstrate the unit's ability to operate around the clock for an extended period of time. While the ash removal system and the system to move material across the bed failed during the tests, the new burner, feed, control and power distribution systems all functioned in an acceptable manner. The test and evaluation showed that improved alloys would be needed in some of the parts to achieve the desired results. EPA ORD's support has helped the NCDA&CS focus on which areas of the system require repair and additional modifications to achieve overall design goals.

Read the final report titled *Progress Report: Transportable Gasifier for On-Farm Disposal of Animal Mortalities (published 2016)*.

Partners: Washington Metropolitan Area Transit Authority (DC); Fort A.P. Hill Fire Department (VA); Lawrence Livermore National Laboratory (CA); Massachusetts Institute of Technology Lincoln Laboratories; Sandia National Laboratories (CA, NM); Virginia Department of Environmental Quality; Laboratory Response Network laboratories (FL, MI, MN, NY, OH, VA)
Challenge: Cleanup of a *Bacillus anthracis* contaminated subway, in collaboration with the U.S. Department of Defense (DOD), and U.S. Department of Homeland Security (DHS)
Resources: Full-scale demonstration of technologies
Project Period: 2016 – 2018

"The work being done with the Underground Transportation Restoration Operational Technology Demonstration project has been critically important to helping Washington Metropolitan Area Transit Authority and other mass transit properties face the daunting preparedness challenges associated with an accidental or intentional release of a biological agent in the underground transportation environment. The project has helped inform our leadership in determining operational strategies that will lead to a more rapid return to service following such an event." – Homeland Security Investigations and Intelligence Bureau Metro Transit Police Department, CBRN Coordinator Brandon Graham

Following the 2001 *Bacillus anthracis* (bacterium that causes anthrax) attacks, cleanup of the Hart Senate Office Building and Brentwood postal facility cost in excess of $1 billion, and it resulted in the Brentwood postal facility being closed for over two years. Since that time, EPA ORD has done a great deal of work to improve the nation's ability to cleanup buildings contaminated with *Bacillus anthracis* or other biological agents. In recognition of the complexities that would be involved, and the number of cities that have underground rail systems, EPA along with the Department of Homeland Security (DHS), DOD and several national laboratories turned their attention to the cleanup of subway systems that could be contaminated with *Bacillus anthracis*.

The Underground Transportation Restoration (UTR) Operational Technology Demonstration (OTD) was conducted during September 2016 at Fort A.P. Hill's Asymmetric Warfare Training Center to evaluate decontamination technologies that could be used in the event of a *Bacillus anthracis* incident in a subway system. The project used a non-pathogenic surrogate that behaves much like *Bacillus anthracis* spores in terms of how it is transported in the air, settles and how it can be killed. The project consisted of two rounds of background sampling, agent release, decontamination, sampling, waste removal and decontamination, and post-decontamination sampling. The technologies that were evaluated included a fogger that produced a fog from diluted bleach and a skid mounted sprayer that sprayed a liquid pH adjusted bleach solution. Both technologies were selected because they are off-the-shelf and could easily be purchased in an emergency.

A report was published in 2018 that thoroughly analyzed each step of the cleanup process (gathering of samples, cleanup methods, waste management) as well as cost associated with each. The results of this study concluded that there was no significant difference between the two cleanup methods. Utilizing approaches that reduce cost, such as composite sampling which decreases the need for labor and supplies, data management, sample shipment, and laboratory analysis, could make cleanup more manageable. The study noted that waste management is an integral piece of the cleanup process and should be determined both during pre-incident and response planning due to its impact on cost and logistics. This information was provided to DHS which has developed site-specific plans for San Francisco and New York as well as guidance that could be used in other cities.

Read the final report titled *Underground Transport Restoration (UTR) Operational Technology Demonstration (OTD).*

Partners: Colorado, District of Columbia, Mississippi, Oklahoma, Tennessee, Vermont and Wisconsin state environmental and/or public health agencies
Challenge: Enabling state and local communities to rapidly respond to ricin contamination
Resource: Technical assistance to aid field and laboratory approaches for sampling and analysis, operationally applying decontamination methods, and strategically handling wastes
Project Period: 2013 – 2019

"Working with the EPA in response to this Ricin incident proved to be invaluable. They provided remediation expertise and testing resources that saved our agency significant staff time. Thanks to their support, the property was appropriately decontaminated, eliminating any potential for future concern. Further, their knowledge and availability helped to ensure that we could quickly respond to the needs of the community."
– Boulder County Public Health, Water Quality and Hazardous Waste Coordinator Erin Dodge

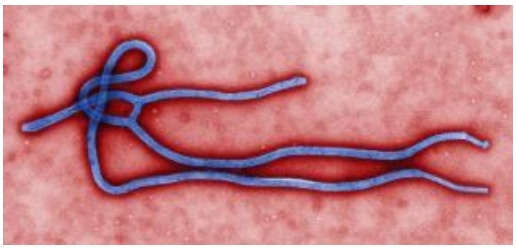
Ricin is a deadly biological toxin that is easily produced from castor beans, making it one of the most worrisome biological threat agents. Multiple ricin incidents occurred following episodes in the popular television show "Breaking Bad" that featured its production. EPA ORD researchers and subject matter experts from the CBRNE Consequence Management Advisory Division in EPA's Office of Land and Emergency Management/Office of Emergency Management were called upon by EPA Regions 1, 3, 4, 5, 6 and 8 to support various state and local communities during independent ricin incidents spanning several years (2013 to 2019). EPA researchers developed innovative applied solutions to the challenges encountered during the first ricin responses leading to significantly shortened response times and decreased costs and resources required for the subsequent ricin incidents. The developed tools provide the federal government with important new capabilities for helping states and local communities respond to ricin incidents.

As one recent example, EPA ORD researchers rapidly supported EPA Region 8's (Mountains and Plains) response to a ricin incident at a condominium in Boulder, Colorado. The applied solutions directly informed the sampling plan, sample analysis, decontaminant selection, decontamination of responders and their equipment, and handling of the ricin waste. Because the laboratory used ORD's recently developed sample processing (sample cleanup and concentration) method, some post- decontamination samples indicated that ricin was still present in the condominium; these method removed analytics interferences and, thereby, increased the capability to detect ricin in environmental samples. This information enabled state decision makers to determine that further decontamination of the unit was required to protect public health. Without this research, the condominium could have been declared clean and safe for re-occupancy when in fact ricin would have remained.

These efforts enabled the states and local communities to rapidly respond to ricin contamination incidents and effectively clean up the affected areas. EPA researchers helped close scientific gaps, transition scientific solutions, and enabled the states and local communities to be ready to rapidly respond to the next ricin or other biotoxin incident.

Read the journal article produced from this project titled *Sample Processing Approach for Detection of Ricin in Surface Samples* (published 2017).

Partners: Maryland Department of Health (DOH), New York State Department of Environmental Conservation (NYSDEC)
Challenge: How best to decontaminate materials and manage waste and wastewater contaminated with the Ebola virus
Resources: Technical assistance
Project Period: 2014 – 2016



"During the 2001 and 2006 anthrax incidents in New York City and the 2014 Ebola crises, New York state reached out to EPA ORD and Region 2 staff for their experience and acumen to collaborate on creating a 'complete waste solution.' This involved designing training sessions, developing a computerized decision support tool (I-WASTE), a NYC Environmental Response and Remediation Plan for Biological Incidents, and conducting and publishing research on the ability of commercial autoclaves to treat thermally resistant anthrax spores and the triple packaging used for transport of highly infectious agents. EPA ORD and Region 2 staff have been responsive to all of our state's requests for assistance. Collaborative efforts by EPA and the NYSDEC have contributed significantly in the management of biohazardous waste that has been both timely and crucial to protecting public health and the environment in New York State and nationally." – NYSDEC Division of Materials Management Research Scientist Alan Woodard, PhD

In 2014, there was an outbreak of Ebola cases in the United States. EPA ORD researchers were called upon to provide technical support to states in responding to the emergency. EPA ORD scientists provided technical support related to decontamination products and best ways to use them. They also delivered expert recommendations for best decontamination methods for personal protective equipment, a critically important issue for health care workers and others who came into contact with Ebola patients. EPA ORD provided instruction on how waste contaminated with the Ebola virus should be managed and the fate of the virus in wastewater. In addition, EPA ORD participated in a workshop with the Maryland DHMH and contributed to the National Security Council's development of the *Multi-Agency Interim Guidance on Management of Wastes containing Category A Infectious Agents*, such as Ebola. With EPA ORD technical support and assistance, Maryland and New York were in a better position to address the challenges associated with managing waste from the Ebola crisis.

In November 2019 the Maryland Department of Health's Environmental Health Bureau released the report from the 2017 Workshop on "*Managing Highly Pathogenic Medical Waste: Finding a Way Forward*" in which ORD participated. The report, which highlights some of the challenges and opportunities for Maryland in addressing Category A infectious waste, will be particularly relevant for those interested in preparing for the possibility of highly pathogenic emerging infectious diseases in the hospital or community setting.

The report can be accessed on the Maryland Department of Health's Special Medical Waste page.

SUPERFUND AND CONTAMINATED SITE REMEDIATION

Partner: City of Rockford, Illinois Planning and Development Committee
Challenge: Revitalizing and reinvesting de-industrialized, underserved South Main Corridor neighborhood
Resource: Comprehensive Health Impact Assessment (HIA) that incorporates community priorities, analyzes potential health impacts, and provides strategies to maximize benefits and minimize impacts
Project Period: 2020 – Present

"Once complete, the Colman Yards development will serve as a focal point for arts, culture, and community gathering for Southwest Rockford and all members of our community. The City has partnered with US EPA for two decades to make this development a reality. In addition to the Framework plan, US EPA Brownfields Assessment, Cleanup, and Revolving Loan Funds were heavily relied upon to address onsite contamination. Colman Yards would not be a reality without the collaboration of US EPA." – City of Rockford, IL Brownfields Redevelopment Specialist Robert Wilhelmi

Brownfields, a declining infrastructure, and a history of manufacturing have become major physical and mental health concerns to the City of Rockford, Illinois, especially with over one-third of the City's population currently living below the poverty level. Communities like the ones in Rockford, who are recovering from de-industrialization and financial disinvestment, are often beset by a number of factors that could negatively affect their health. The City of Rockford recruited EPA to help assess conditions and inform revitalization plans that could simultaneously address both environmental concerns (contaminated air, water and land) and socioeconomic conditions (employment, education and access to health care).

EPA ORD, in collaboration with the EPA Region 5, worked with the City of Rockford to conduct a Health Impact Assessment (HIA) that analyzed how to perform neighborhood revitalization in a way that maximizes health benefits for residents. During this partnership, the HIA focused on avoiding gentrification and negative social consequences for community members while seeking to preserve cultural values and improve quality of life and public health. The six determinants of health focused on throughout the HIA included: 1) housing, 2) neighborhood and built environment, 3) parks and greenspace, 4) crime and safety, 5) employment and economy, and 6) social and cultural well-being. The HIA provided more than 80 strategies across social, economic, and environmental sectors to maximize the positive effects of revitalization, resulting in several positive developments.

In July 2023, an exciting agreement was approved by the city's Planning and Development Committee to redevelop the 26-acre Barber Colman Complex, which will result in an accrued population increase of 2,710 people and an accrued employed increase of 2,784 jobs over the next seven years. The complex, which has been sitting abandoned for 22 years, will undergo historical rehabilitation, new construction, hundreds of new multi-family units, commercial space, public green spaces, and an activated riverfront.

As a result of its success, this HIA has demonstrated that collaborative decision-making can increase the vibrancy and overall health of communities across the country.

Partners: Oregon Department of Environmental Quality (DEQ)
Challenge: Legacy heavy metal soil contamination from past mining activity
Resource: Prescription for soil amendments to enhance revegetation
Project Period: 2017 – Present

"EPA researchers developed a prescription for amending contaminated mine tailings at the Formosa Mine Superfund Site to support the establishment and growth of vegetation where none was growing due to contamination. The research work is providing a site-specific biochar formula suited for the site conditions. Not only is this a significant scientific contribution that will prevent the offsite movement of contaminants at the site, help facilitate the removal of this site from the NPL and support long-term cleanup, but this kind of technology will be useful at numerous other contaminated sites across Oregon." – Oregon DEQ Hydrogeologist Bryn Thoms

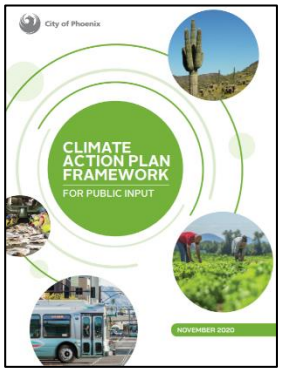
Past mining activities in the United States have left a legacy of soil and mining residues contaminated with heavy metals. Before plant growth can reach levels adequate enough to stabilize the soil, the bioavailability (absorption of the contaminants into living tissue) and acid levels generated by waste rock need to be reduced. EPA's Superfund program oversees cleanup of these sites. However, with limited resources, the highest priority for remediation goes to the most hazardous sites. In the meantime, many sites receive little or no attention. Often simple steps such as establishment of plant cover can reduce wind and water erosion of contaminated waste materials and the subsequent contamination of downslope receiving waters.

Of special concern is the Formosa Mine Superfund Site in south-central Oregon. This mine has a large area of tailings where it is difficult to establish vegetation. EPA ORD and Region 10 (Pacific Northwest) and the U.S. Department of Agriculture's Agriculture Research Service partnered to develop new techniques to assist in this cleanup. These techniques use soil amendments that adjust the pH, absorb heavy metals, and provide nutrients essential for plant establishment and growth. By creating a favorable rooting environment with amendments, plants can get established and protect the site from wind and water erosion, preventing the movement of contaminated soil.

The amendments used at the formosa mine include lime for neutralizing acidity and raising soil pH; biosolids (organic matter recovered from a sewage treatment process and used as fertilizer to supply carbon and nutrients for plant growth); and biochar (a charcoal-like material made by heating waste wood in the absence of oxygen to sorb metals, lower soil bulk density, and improve water infiltration and retention).

Results show that with these amendments the conditions for plant establishment and growth at the Formosa Mine dramatically improved. Douglas fir trees and herbaceous plants grew in amended tailings. Without amendments, the tailings are barren and do not support plants. Tree mortality was observed because surface runoff from unamended tailings overcame the acid neutralizing effectiveness of the lime and soil pH dropped, causing tree mortality. This suggests that all exposed waste rock and tailings need to receive amendments, including sufficient lime to neutralize residual acidity to prevent this from occuring in the future especially in downslope positions. Monitoring is also important as lime and biosolids may need to be reapplied occasionally to support long-term plant health. Other mine sites can use these types of amendment combinations and prescriptions to improve contaminated or degraded soils to establish plants and support their growth. Over time plants will improve soil health and prevent flow of heavy metals downstream from these mine sites.

Partners: City of Phoenix; Arizona Department of Environmental Quality (DEQ)
Challenge: Community vulnerability to contaminated sites and waste facilities due to climate change and extreme events
Resources: Suite of indicators and hazards maps
Project Period: 2017 – 2022



"The City of Phoenix used [ORD's] extreme heat indicators and maps in their 2021 Climate Action Plan (CAP) and related presentations to the public. ORD's social vulnerability indicators may be used to assist with equitable decision-making as they relate to heat and water resilience in the CAP. The City's Office of Homeland Security and Emergency Response may also use, as feasible, the indicators and maps for hazard mitigation planning." – City of Phoenix Rosanne Albright

The City of Phoenix was concerned about the current and future effects of rising temperatures and drier conditions on their communities, particularly as they relate to the risks associated with nearby contaminated sites. With their eyes set on an inclusive and equitable climate action plan, the City pursued a roadmap for advancing climate resiliency and making more informed decisions.

EPA ORD, in collaboration with EPA Region 9 (Pacific Southwest) partnered with the City of Phoenix and Arizona DEQ to find the most relevant data, build a suite of indicators and hazard maps, and create useful outreach and communication materials to share as part of the plan and more broadly with other regions and municipalities.

The project ultimately produced community and contaminated site indicators and hazard maps in partnership with the City of Phoenix, Maricopa County, and Arizona DEQ. The results have benefitted the City of Phoenix by providing: 1) a greater understanding of the type and magnitude of hazardous sites in the project area, 2) maps that could be used for emergency preparedness and response,
3) scenarios that mapped extreme heat, drought, wildfire and flooding, and 4) the characteristics of the population, particularly those most vulnerable.

Partner: Florida Department of Environmental Protection, City of Jacksonville
Challenge: Assess the fraction of arsenic that is bioavailable in contaminated creek sediment
Resource: Validation of EPA method to assess arsenic bioavailability in aquatic environments and investigation of bacterial communities in sediment as potential indicators of bioaccessibility
Project Period: 2018 – 2020

"The Fairfax St. Wood Treaters Superfund Site is a great example of partners working together successfully. It was a collaborative effort in all aspects of the cleanup, including review of the sediment sampling data for Moncrief Creek." – Florida DEP Project Manager Miranda McClure

Heavy metal contamination of soils is a pervasive problem that is a source of significant human health and ecological risk. Bioaccessibility describes the portion of a heavy metal in contaminated media (soil/sediment, water, air) available to be taken up by the ecosystem. It is an important consideration when assessing ecological risk of contaminated sites. Methods to measure the bioaccessibility of arsenic (As), which was widely used in the past as a wood preservative, do not take into account aquatic sediments. This research was undertaken to determine 1) if EPA Method 1340, an *in vitro* bioaccessibility assay (IVBA) developed for lead (Pb) and arsenic (As) in soils, can be used to assess As in creek sediments and 2) if there is a relationship between bioaccessible As and sediment bacterial communities that would be useful for risk assessments.

EPA ORD, in collaboration with EPA Region 4 (Southeast), collected *As*-contaminated sediments from the on-site retention pond and along a creek near the Fairfax Street Wood Treaters facility, which had become a Superfund site. Elevated levels of As in the pond and creek were detected. Once detected, the pond and creek sediments were subjected to the IVBA, a *Hyalella azteca* sediment toxicity test, and analysis of bacterial community composition using molecular biological and statistical methods.

Total As ranged from 2 – 52 ppm, with 29 – 95% being bioaccessible. Arsenic bioaccessibility appeared inversely related to total As concentration. There was no statistically significant difference in percent bioaccessible As whether the sediments were dried, as prescribed for the soil IVBA, or left wet—suggesting the soil IVBA Method 1340 is suitable for sediment analyses. The results showed that an IVBA for As in sediments and bacterial community analyses could both be developed for ecological risk assessments. The results from sampling Moncrief Creek helped also helped to show As in the sediments did not pose an ecological risk.

Partner: Arizona Department of Environmental Quality (ADEQ)
Challenge: Jet fuel contamination of soils and aquifer at the former Williams Air Force Base Superfund Site
Resource: Technology transfer and technical support for remediation of jet fuel, in collaboration with the U.S. Air Force (USAF)
Project Period: 1998 – 2016

"The ADEQ appreciates the support EPA ORD has provided at the former Williams Air Force Base Site (ST012 former fuel depot jet fuel release site). ORD personnel provided a comfort level to ADEQ to the extent that ADEQ could confidently champion innovative technology use at this site."
– ADEQ Environmental Associate Engineer Wayne Miller

The former Williams Air Force Base in Mesa, Arizona, was commissioned as a flight training school in 1941, and pilot training was its primary mission throughout the history of the base. Fuel storage and distribution operations were conducted at the site (known as ST012), and releases from these systems contaminated the underlying soil and groundwater. The fuel reached depths of approximately 240 feet below ground surface, before the groundwater started rising, smearing the fuel within the aquifer. The base was closed in 1993, and the majority of the property has been converted to the Phoenix-Mesa Gateway Airport and college campuses, among other uses.

Around 1998, EPA Region 9 (Pacific Southwest) and ADEQ requested technical support from EPA ORD to discuss steam enhanced extraction (SEE) with the USAF as a potential remedy for the ST012 fuel spill. With continued technical support from ORD, a pilot study steam injection was implemented in 2008, which recovered an estimated 10,000 gallons of jet fuel. Based on the success of this pilot, a larger scale SEE remediation was initiated in 2014, and operations continued until early 2016. Three different vertical zones of the aquifer were treated, ranging from 140 to 240 feet below ground surface. The total volume of the treatment area was 410,000 cubic yards. More than 300 million pounds of steam were injected, and more than 2.6 million pounds (388,000 gallons) of petroleum hydrocarbons were recovered. The recovered jet fuel was burned in a thermal accelerator or recycled.

EPA ORD technical support for this project included assistance in choosing steam injection as the remedial technology, review of all technical documents (including the design and the remedial action work plan), monitoring the implementation of the technology, and oversite of the implementation of enhanced bioremediation as a polishing step. This technical support has been instrumental in EPA Region 9, the USAF and ADEQ moving forward in cleaning up the impacted areas of Williams Air Force Base.

More information can be found on the Williams Air Force Base Superfund Site profile.

Partners: Colorado Department of Public Health and Environment and other state partners
Challenge: Identifying locations of metals loading to surface water from impacted mine pools, groundwater, and surface water
Resource: High resolution temperature and conductivity sensor networks along key stream sections, in collaboration with the U.S. Geological Survey (USGS)
Project Period: 2018 – Present

"With data and monitoring available through the sensor network, we have been better able to understand mine drainage across sites and make informed decisions about where to conduct remediation or additional analysis." – Colorado Department of Public Health and Environment, Remedial Project Manager Mark Rudolph

More than 500,000 abandoned mines found in the U.S.—particularly in western states—present risks to surface water, groundwater, and human and ecological health due to the volume and toxic nature of the waste produced at these sites. They also present challenges to those tasked with addressing related public health risks and leading environmental cleanup efforts, primarily EPA, states and tribes. Mining sites make up a significant portion of the national Superfund site portfolio in these states.

Mine drainage refers to any surface water or groundwater that drains from an active or abandoned mining operation. The impact of such drainage on water quality can range from minimal, leaving it similar to a natural state, to severely degraded. Polluted mine drainage can be extremely acidic and often consists of high concentrations of toxic, heavy metals. The more acidic the water, the more likely it is to be harmful to living organisms. Measuring the ecosystem health of surrounding surface water has historically involved limited sampling, providing only a snapshot of conditions that can quickly change.

EPA ORD, in collaboration with EPA Region 8 (Mountains and Plains), and with help from other partners, deployed a dense network of sensors that provide accurate water quality measurements on a continual basis. USGS provided equipment and assisted with deployment, data collection and interpretation using fiber optic distributed temperature sensing.

Colorado Department of Public Health and Environment, other state partners and remedial project managers were able to share results of specific sites, lessons learned, and provide additional support using these technologies. Best practices were captured and shared with key partners to improve strategies and lower costs associated with these mitigation efforts.

EPA researchers and their partners are now applying what they learned from developing and deploying the sensor network to develop a conceptual site model and advance the understanding of the interactions of mine pools, shallow groundwater, and surface water, even across large, diverse mining districts. This work is helping managers better target mine sites for analysis and remediation, significantly reducing costs to federal, state and tribal partners. Data sets and successful deployments have resulted in using these and similar technologies at other mining sites in Colorado and Utah including, EPA's Regional-State-Tribal Innovation Projects selected in 2019 and 2020.

Partners: Delaware Department of Natural Resources and Environmental Control (DNREC); Kent County Economic Development; City of Dover Planning, Inspections, and Community Development
Challenge: Informing decision makers on potential impacts on health, food access, and economic development from brownfield revitalization in the City of Dover
Resource: Rapid Health Impact Assessment (HIA)
Project Period: 2017 – 2018

"The rapid HIA for the Chesapeake Utilities site provided the opportunity to envision a more positive future for this former brownfield. The process challenged all of the partners to think not only about bringing this property back into a productive state, but also about the many benefits healthy food production and access will bring to the community. We all appreciate the leadership and expertise EPA provided for this project." – State of Delaware, Office of State Planning Coordination Principal Planner David Edgell

"The city has been working on housing and crime issues, but without adequate access to healthy foods, these households would still struggle; the rapid HIA provided a setting which made cross-disciplinary discussions possible."– City of Dover Director of Planning, Inspections and Community Development Dave Hugg

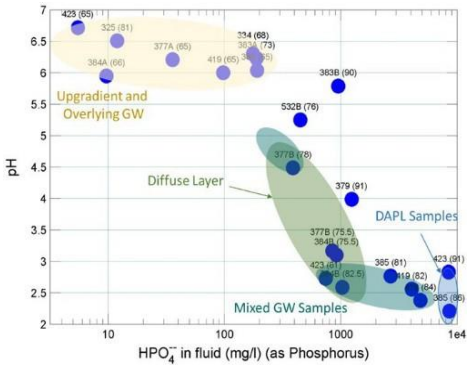
The City of Dover, Delaware and Kent County sought to redevelop a vacant and formerly contaminated property, or brownfield, to spur revitalization in the downtown Dover area. Given a desire to increase food access in and around Dover, local and state officials sought assistance with examining a cleaned brownfield site for economic development through food production; of particular interest was an integrated fish and plant farming option known as aquaponics. An EPA Region 3 (Mid-Atlantic) land revitalization team developed an Aquaponics Business Plan User Guide to assist communities facing the challenge of identifying and implementing reuse alternatives for brownfields.

Health Impact Assessment (HIA) is a systematic approach that uses various data sources, analytical methods, and input from stakeholders to determine the potential effects of a proposed policy or project on the health of a population and provides recommendations on managing those effects. EPA ORD hosted a training workshop on the HIA process for EPA Region 3 (Mid-Atlantic) and interested parties from Delaware State University, the City of Dover, Kent County, and Delaware state government, including the Department of Health and Social Services and DNREC. Building on the successes of the Aquaponics User Guide and HIA workshop, EPA ORD scientists, in collaboration with EPA Region 3 and the Office of Brownfields and Land Revitalization, agreed to work with local and state officials and community partners to conduct an HIA in July 2017.

EPA ORD has piloted a rapid HIA – an abbreviated form of HIA – for partners to select among brownfield revitalization projects to improve food security in Dover. EPA ORD scientists guided the HIA process and utilized a variety of methods to evaluate the health impacts, including qualitative and quantitative data gathering, geographic information system (GIS) approaches, and literature review. An HIA report has been developed that documents the HIA analyses, findings, and recommendations for the City of Dover to consider public health when making decisions related to the revitalization project. This report also outlines opportunities for further development and future assessments.

Read the final report titled *Former Chesapeake Supply Brownfield Revitalization: Rapid Health Impact Assessment*.

Partner: Idaho Department of Environmental Quality (IDEQ)
Challenge: Groundwater geochemistry study at the Simplot Operable Unit, Eastern Michaud Flats Superfund Site
Resource: Technology transfer and technical support for understanding groundwater geochemical processes at a phosphoric acid plant
Project Period: 2013 – 2016



"The subsurface investigation at the Don Plant was an important step in better understanding the nature and sources of low pH dense aqueous phase liquids (DAPL) present in the Phosphoric Acid Plant (PAP) area. The results of this investigation, along with evaluation of monthly monitoring results from selected wells in the PAP, helped identify that more than one type of low pH DAPL was pooling on top of the clay in late 2015 and 2016 – one DAPL was high in phosphorus and the other was high in sulfate, suggesting separate process sources." – IDEQ, Pocatello Region Mining Project Manager Margaretha English

The Don Plant fertilizer manufacturing facility is part of the Eastern Michaud Flats Superfund Site. It is a phosphoric acid/liquid plant located near Pocatello, Idaho. Process liquids released from the plant site, which are relatively dense and low-pH aqueous solutions, have migrated vertically through the groundwater column to the top of the American Falls Lake Bed clay layer. The dense aqueous phase liquid forms pools and migrates along the top of the clay layer towards the Lower Portneuf River. In order to control contaminant migration, groundwater extraction wells are pumped to recover the dense aqueous fluids. However, mineral solids precipitate as a result of pumping within the groundwater extraction wells. The mineral precipitation is sufficient to hamper the effectiveness of the pumps, in some cases even spark failure. The concern was to understand the geochemistry within the aquifer that was causing these wells to foul and to develop solutions to keep these extraction wells operating to reduce contaminant mass from moving towards the Lower Portneuf River. Additional data were needed to identify the cause of mineral precipitation and develop a plan to address the pump fouling issue when the groundwater extraction system is operating.

EPA Region 10 (Pacific Northwest) and the IDEQ first requested EPA ORD technical assistance in 2015 to support the development of a work plan designed to better understand the pump fouling problem. Technology transfer efforts by ORD scientists and the IDEQ/Region 10 team resulted in a plan to sample, analyze and identify mineral precipitates and develop a geochemical model that could predict mineral precipitation in the extraction wells.
ORD scientists continued to provide technical assistance as the study data were obtained, and they reviewed the technical aspects of the data analysis and modeling. Recommendations were provided to possibly reduce or prevent mineral fouling in the extraction wells. To date the extraction wells have helped mitigate downgradient migration of dense fluids.

More information can be found on the Eastern Michaud Flats Superfund Site profile.

Partner: Louisiana Department of Environmental Quality (DEQ)
Challenge: Contaminated groundwater from former battery demolition site entering neighborhood creek
Resource: Technical assistance in mitigating off-site acid and heavy metal impacts
Project Period: 2004 – Present

"The permeable reactive barrier wall allows us to be protective of the waters of Selsers Creek. ORD's assistance with the testing of the wall was essential. Our collaboration with our federal partner was key to completing this mission at Delatte Metals Superfund site, and we continue to cooperate with EPA and ORD on other issues at this site." – Louisiana DEQ Secretary Chuck Carr Brown, PhD

Past activities at the Delatte Metals Superfund site in Ponchatoula, Louisiana, involving processing spent lead-acid batteries and smelted lead plates have resulted in significant contamination of groundwater. Contaminants include sulfuric acid, lead, cadmium and nickel. The site borders a large creek that runs adjacent to a residential neighborhood. In order to mitigate impacts to the creek, a permeable reactive barrier (PRB), consisting of limestone and composted cow manure, was installed parallel to the creek to intercept the impacted groundwater and both neutralize the sulfuric acid and remove the heavy metals prior to entry of the groundwater into the creek.

EPA ORD has been working with the Louisiana DEQ and EPA Region 6 (South Central) to evaluate the long-term performance of the PRB in preventing discharge of contaminants into the creek. Monitoring and evaluation—involving groundwater sampling for metals and geochemical parameters, hydraulic conductivity and flux measurements, and PRB core analysis—are being used to assess performance and identify potential issues impacting long-term performance.

The PRB has performed well for over 14 years with performance monitoring scheduled to continue in coordination with the Louisiana DEQ and EPA Region 6. The sulfuric acid is being fully neutralized, and metals are being effectively removed (e.g., Pb from 100 µg/L up gradient to <0.09 µg/L within the PRB and Cd from 66 µg/L to <0.07 µg/L). Observed gradual changes in geochemical parameter measurements suggest, as expected, that the effectiveness of the PRB will have a finite lifetime. Louisiana DEQ and EPA ORD will continue to monitor PRB effectiveness to determine if contaminant levels decrease to safe levels, sparing the cost of replacement.

Partners: Massachusetts Department of Environmental Protection (MassDEP), Massachusetts Development Finance Agency (MassDevelopment)
Challenge: Defining the extent and nature of contaminant impact to groundwater and a recreational lake from a landfill at the Former Fort Devens; providing technical analysis of viable alternatives to stop contaminant impacts to off-site public and private properties
Resource: Applying novel methods for detailed assessment of groundwater and contaminant movement in a complex setting, in collaboration with the U.S. Army
Project Period: 2014 – Present

"EPA ORD's involvement has been essential to the ongoing development of a groundwater model that can be used to support a remedy modification. Because of the technical complexity and importance of this project, it is doubtful that the results from the model could be accepted by the state without EPA ORD's participation." –MassDEP, Devens Project Manager David Chaffin

The Former Fort Devens made use of an onsite landfill for solid waste generated during several decades of operations. The landfill was not equipped with a system to prevent release of landfill leachate into the underlying aquifer. The resulting contaminated groundwater has since moved beyond the base property, impacting an adjacent recreational lake (Plow Shop Pond) and the aquifer underlying the Town of Ayer, MA.

EPA ORD, in collaboration with EPA Region 1 (New England) and the U.S. Army, implemented a monitoring program during 2005-2008 to clearly define the location and nature of impact to Plow Shop Pond.
This established that contaminated groundwater entering the lake was caused by leachate migration from the eastern edge of the landfill, causing contamination of lake sediment and water.

The multi-year effort included installation of supplemental monitoring locations and collection of detailed chemistry data to define the source of arsenic contamination observed in the lake. Confirmation that the landfill was the source of contamination led to construction of a remedy in 2013 to remove existing and prevent future contamination of the lake. Subsequent work (2014-2019) evaluated improvements in lake water and sediments in response to the 2013 remedy. Continued work will evaluate the success of the interim groundwater remedy installed at the northern edge of the landfill and allow stakeholders to select a permanent solution to address contamination impacting groundwater under the Town of Ayer, MA.

More information can be found on the Fort Devens Superfund Site profile.

Partner: Massachusetts Department of Environmental Protection (MassDEP)
Challenge: Chemical contamination of soils and aquifer at the General Chemical Corporation facility
Resource: Technology transfer and technical support for remediation of chlorinated solvents and petroleum hydrocarbons
Project Period: 2012 – 2017

"MassDEP greatly appreciates the expert advice we have received from EPA ORD on the General Chemical TSDF assessment and cleanup plans. MassDEP has been assisted with technical support from ORD for this site since 2012. At each point, ORD has provided valuable input, particularly with respect to the merits of thermal and chemical oxidation remedies. It has been a great service to the state program to receive the views of national experts on these complex investigative and remedial issues." – MassDEP Bureau of Waste Site Cleanup, Steve Johnson

From 1960 to 2012, General Chemical Corporation (GCC) operated a permitted Treatment, Storage and Disposal Facility (TSDF) with waste management operations that included the storage and repackaging of bulk virgin solvents for resale, and the storage and consolidation of hazardous and nonhazardous wastes. The facility is the location of multiple historical releases. Contaminants include both petroleum hydrocarbons and chlorinated solvents, which impact the soils and groundwater at the facility. The contamination extends off site to former residential properties, under a wetland, and contaminants discharge to a drainage ditch that flow into a brook. A public elementary school abuts the site to the west/northwest.

In 2012, MassDEP requested technical support from EPA ORD to review the Remedy Implementation Plan prepared for the site by GCC's consultants. ORD scientists and engineers recommended that additional site characterization be carried out to better define the extent of the contamination, and then that the potential remedial actions be re-evaluated. MassDEP required the recommended additional site characterization, and ORD reviewed and commented on the subsequent Data Gap Action Plan Report (2013) and Remedial Action Plan (2016). The re-evaluation of remedial actions based on the additional characterization information led to a change in the recommended remedy for the site.

ORD's technical support helped lead to thermal remediation being chosen as an appropriate main remedial technology for the site due to the large contaminant mass that is present. Suitable remediation will lessen the various threats posed by the contaminants to the environment and human health.

Partner: Minnesota Department of Natural Resources (MDNR); City of Duluth, Minnesota; western Duluth residents and stakeholders, including the Fond du Lac Band of Lake Superior Chippewa
Challenge: Determine the potential public health impacts of proposed habitat restoration and park improvements activities
Resource: Health Impact Assessment (HIA) of two habitat restoration sites in the St. Louis River Area of Concern
Project Period: 2017-2018

"Through the HIA, EPA's team brought in a wide variety of methods and metrics capable of assessing these, and other, objectives as they relate to important health pathways. The HIA team involved members of the community through an extensive public input process, which was important as the Project areas are in close proximity to residential neighborhoods. EPA's assessments resulted in recommendations that were integrated in the Project design. We feel that the HIA process and products were a valuable addition to this Project's development."
- MNDNR Habitat Coordinator Melissa Sjolund

The St. Louis River Area of Concern (AOC) along the Minnesota-Wisconsin border is one of 25 remaining U.S. Great Lakes AOCs named under the U.S.-Canada Great Lakes Water Quality Agreement—a commitment to restore and protect the waters of the Great Lakes. The St. Louis River was named an AOC because of legacy pollution and habitat losses that impair the beneficial uses of the ecosystem. To help restore beneficial uses in the St. Louis River ecosystem, the Minnesota Department of Natural Resources (MNDNR) proposed to restore approximately 200 acres of aquatic habitat at Kingsbury Bay and Grassy Point, which are owned by the City of Duluth and managed as community green space.

At the request of stakeholders, EPA ORD conducted a Health Impact Assessment (HIA) in 2017 to examine the potential public health impacts of the proposed MNDNR habitat restoration work and the subsequent park improvement activities to be carried out at these sites by the City of Duluth. Using a mix of scientific methods and input from stakeholders, community members, and scientific researchers, the HIA identified the pathways through which the proposed project could potentially impact health. Completed in 2018, the HIA provided evidence-based recommendations to MNDNR and the City of Duluth to address any disproportionate health impacts, mitigate potential adverse health impacts, and bolster potential health benefits of the project.

The HIA found that though some short-term negative impacts were possible, the proposed habitat restoration and park improvements work was expected to have a net positive, long-term impact on public health and community well-being. These positive impacts included improved water quality and aquatic habitat, beautification and maintenance of created green spaces, increased opportunity for recreation and physical activity, and space for engagement with nature, social interaction, spiritual reflection, and access to cultural resources, such as wild rice**.** MNDNR utilized recommendations from the HIA to inform the design and implementation of the habitat restoration, which was completed in 2021. Following revegetation efforts, the City of Duluth began park improvement activities including adding new and improved trail surfaces, new signage, and interpretative kiosks. In 2022, a new fishing pier will also be installed at the location recommended by the community in the HIA.

Read more about the **Kingbury Bay-Grassy Point HIA**.

Partner: Montana Department of Environmental Quality (DEQ)
Challenge: Remediation activities for Barker Hughesville Superfund Site
Resource: Technical Investigation in collaboration with the U.S. Forest Service (USFS) and EPA Region 8
Project Period: 2009 – 2016

"DEQ collaboration with EPA Region 8 and ORD at these two Superfund sites had enabled us to coordinate between the sites and to consider the effectiveness of pilot tests at locations across the sites."
– Montana DEQ, State Project Officer Keith Large

EPA ORD provided technical assistance to EPA Region 8 (Mountains and Plains) in their effort to evaluate ongoing and future remediation activities for the Barker- Hughesville and the Carpenter Snow Creek Superfund Sites located within the Helena-Lewis and Clark National Forest in Cascade and Judith Basin Counties, Montana.

Barker Hughesville
Barker Hughesville is a 6,000-acre site, where commercial mining operations were carried out between 1879 to 1940s. These operations left several hundred thousand cubic yards of mine waste distributed among 46 known abandoned mines and along nearby creeks. Both private and U.S. National Forest Service (USNF) land is impacted. The site also contains 17 adits that discharge mine water that contaminates nearby surface water bodies.

Carpenter Snow Creek
Carpenter Snow Creek site is a 9,000-acre site, where commercial mining operations were also carried out between 1879 to 1940s.

Together, the operations left over 1.2 million cubic yards of mine waste distributed among 90 known abandoned mines and nearby creeks impacting both private and National Forest Service administered lands. The site also contains 22 discharging adits of various water quality.

Due to the widespread nature of contaminated soil, sediment, streamside deposits, surface water and groundwater with arsenic, copper, zinc, cadmium. manganese, thallium and lead, both sites were listed on the National Priority List of Superfund sites in 2001. While EPA has the lead on the Remedial Investigation and Feasibility Study at the Barker Hughesville site, Montana DEQ is developing the Remedial Investigation and Feasibility (RI/FS) for the Carpenter Snow Creek site. ORD has collaborated with Region 8, DEQ and the USFS in the evaluation of mine water treatment performed using sulfate-reducing bacteria to remove sulfate and metals in water collected at the adit of Big Seven Mine and Haystack Mine located in the Carpenter Creek site. Mine water was collected by DEQ's contractor and shipped to ORD's laboratory facilities in Cincinnati, Ohio for bench- scale testing. ORD has also helped Mt Emmons Mining Company, EPA Region 8, USFS and DEQ with evaluating the effectiveness of sulfate-reducing bacteria in treating water at the Danny T mine in Barker Hughesville where Mt Emmons Mining Company is under and EPA order to conduct these laboratory tests. Additionally, ORD has collaborated in providing technical comments on the feasibility studies of the remediation of several abandoned mines and the overall remediation approach at both sites.

More information can be found on the Barker Hughesville Superfund Site profile.

Partner: Nevada Division of Environmental Protection (DEP)
Challenge: Groundwater characterization and remediation at the Anaconda Mine Site (Lyon County)
Resource: Technical assistance and review of groundwater background conditions and groundwater characterization to assess the amount and type of groundwater contamination
Project Period: 2004 – 2016

"ORD's technical assistance has been essential in characterizing the complex hydrogeological conditions and extent of groundwater contamination at the Anaconda Mine Site, setting the stage for evaluation of remedial options." – Nevada DEP, Administrator Greg Lovato

The Anaconda Mine Site has uranium and previous copper ore mining. Hydrology at the Anaconda Mine Site is complex and subject to significant uncertainty, particularly with respect to the effects of local hydrology on long-term contaminant migration. Since naturally occurring sources of uranium and sulfate exist in the area, establishing background concentrations of uranium and sulfate in groundwater is also critical to understanding the extent and magnitude of groundwater contamination.

EPA ORD has provided technical assistance on and reviews of estimated background concentrations of site constituents, groundwater characterization, and groundwater/geochemical modeling efforts, as well as technical analyses that will be used to evaluate possible remediation options. Nevada DEP Abandoned Mine Land Program, in conjunction with EPA Region 9 (Pacific Northwest), is using the analyses provided by ORD to help design both better remediation strategies and better monitoring systems for the abandoned mine complex.

More information can be found on the Anaconda Copper Mine Superfund Site profile.

Partner: New Hampshire Department of Environmental Services (NHDES)
Challenge: Suitable groundwater remediation technologies at the South Municipal Supply Well Superfund Site
Resource: Technology transfer and technical support for permeable reactive barrier & thermal remediation
Project Period: 2009 – Present

"EPA ORD personnel have provided invaluable technical support to the South Municipal Well governmentteam."
– NHDES Waste Management Division, KennethRichards

The South Municipal Water Supply Well Superfund Site located in Peterborough, New Hampshire, includes the New Hampshire Ball Bearings (NHBB) property, adjacent wetlands, commercial/residential properties, and the South Municipal Water Supply Well. Installed in 1952, the South Well provided water to Peterborough for nearly 30 years. In 1982, concentrations of volatile organic compounds were detected in the South Well at levels above 100 parts per billion and use of the well discontinued. Initial groundwater and soil cleanup actions at the site included in-situ vacuum extraction and groundwater pump-and-treat using air stripping and carbon adsorption. In 2010, revised groundwater remedies were initiated to include a combination of two treatment technologies: 1) thermal remediation within targeted source areas, and 2) in-situ groundwater treatment using a zero-valent iron permeable reactive barrier (PRB).

NHDES and EPA Region 1 (New England) first requested EPA ORD technical assistance in 2009 for information on innovative remediation technologies, including thermal, enhanced bioremediation, and PRB applications. Technology transfer efforts by ORD personnel resulted in recommendations on bench-scale studies, site characterization and monitoring requirements, and implementation of the thermal and PRB remedies. In 2014, the PRB was installed along the alignment of the former Boston & Maine Railroad (B&M) line to intercept and treat groundwater contaminants emanating from the eastern NHBB property line. Thermal remediation using Electrical Resistance Heating technology was completed in 2016. Approximately 5,000 pounds of tetrachloroethylene (PCE) were removed from the subsurface. ORD personnel continued to provide technical assistance to the NHDES and EPA Region 1 teams by helping to determine the effectiveness of the thermal and PRB remedies, and in determining the location of other source areas that require treatment.

Recent groundwater data collected from the site show that the PRB is failing to meet specified treatment criteria. Current technical transfer efforts being provided include: assistance in interpreting site data; recommendations on study designs for characterizing groundwater and solid-phase properties; and analytical support to help diagnose the cause of the unanticipated inadequate treatment performance.

More additional can be found on the South Municipal Supply Well Superfund Site profile.

Partner: New Hampshire Department of Environmental Services (NHDES)
Challenge: Suitable technologies to remediate waste oils and chlorinated solvents at the Beede Waste Oil Superfund Site
Resource: Technology transfer of Steam Enhanced Extraction and technical support for thermal remediation of waste oils
Project Period: 2007 – Present

"U.S. EPA ORD personnel have provided invaluable technical support to the Beede Waste Oil Government team." – NHDES, Ken Richards

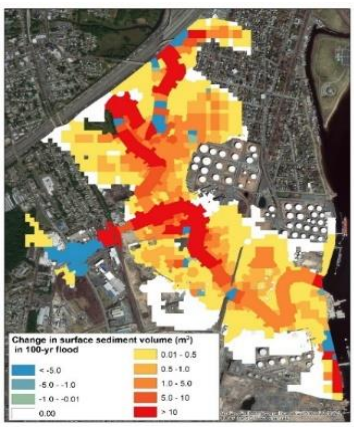
The Beede Waste Oil Superfund Site is located in Plaistow, New Hampshire, within a predominantly residential area. Prior commercial operations at the site, which began in 1926, included storage and distribution of fuel oil and recycling of used oil. Spills, leaks from storage tanks, and discharges to lagoons on the site created subsurface plumes of light nonaqueous phase liquids (LNAPL) that contained a wide variety of petroleum hydrocarbons, polychlorinated biphenyls (PCBs), and chlorinated solvents. The Record of Decision (ROD) chose soil vapor extraction to remediate the smear zone of LNAPL, with a contingency for thermal enhancements if it was determined during the design stage that this was needed in order to meet the site soil cleanup goals. The ROD also included a groundwater extraction system to extract the downgradient dissolved phase plume.

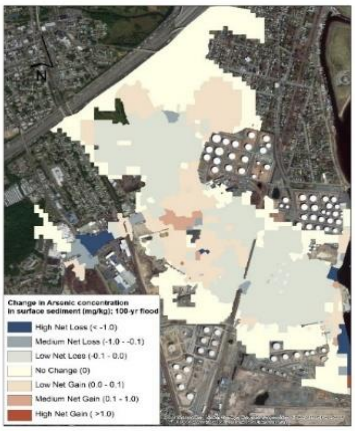
In 2007, NHDES and EPA Region 1 (New England) requested EPA ORD technical assistance to aid in determining if a thermal enhancement to the groundwater extraction system would be required to meet soil cleanup goals, and if so, which of the thermal technologies would be most applicable to this site. In addition, ORD personnel provided technical support on delineation of the area to be treated using thermal remediation.

In 2010, ORD completed a bench scale treatability study that demonstrated that steam injection remediation of the soils was capable of reducing contaminant concentrations to meet the cleanup criteria. Subsequently, Steam Enhanced Extraction (SEE) was chosen as the remediation technique for the two LNAPL-contaminated areas that were delineated by the site characterization activities. From 2015 to 2016, SEE was used to successfully meet the soil cleanup criteria in the Phase 1 area, with the injection of 28.7 million pounds of steam and the recovery of more than 150,000 pounds of contaminants. In late 2018, steam injection was initiated in the Phase 2 treatment area, and this remediation was completed in the Fall of 2019 with the attainment of the soil cleanup goals. Approximately 66.3 million pounds of steam were injected in the Phase 2 area, and 177,300 pounds of contaminants were recovered.

More information can be found on the Beede Waste Oil Superfund Site profile.

Partner: New Jersey Department of Environmental Protection (NJDEP)
Challenge: Assessing public health and related impacts from severe flooding at a contaminated site
Resource: Technical support in collaboration with NJDEP and Grand Valley State University on data sharing and modeling development
Project Period: 2016 – 2021





"Understanding the impacts of climate change – including today's threats of flooding and sea-level rise – enables us to protect our communities against them. This collaborative project with EPA ORD and Region 2 moves us one step towards that shared goal."
– NJDEP Associate Commissioner for Science and Policy Kati Angarone

Extreme weather events (e.g., flood, hurricane) exert multiple stressors on communities. Among these is the possibility of toxic water and sediment being released from Superfund and other contaminated sites. As a coastal state with the highest population density and number of contaminated sites in the country, NJDEP recognizes the importance of planning for and responding to these types of catastrophic events at contaminated sites (e.g., 2016 NJDEP Planning for and Response to Catastrophic Events at Contaminated Sites Technical Guidance). The Woodbridge Chevron refinery facility, a Superfund site in Perth Amboy, NJ, which falls within the 100- and 500-year floodplain, is located near two creeks, and is bounded to the east by the Arthur Kill, which is prone to sea-level changes and storm surge impacts.

In response to these needs, EPA ORD researchers, in collaboration with EPA Region 2 and NJDEP's Site Remediation & Waste Management Program, developed two environmental models to support New Jersey State's climate resilience and help the Perth Amboy coastal community. The models—a coupled hydrodynamic model (HEC-RAS 2D) and an environmental fate-and-transport model—are designed to help users assess potential flooding-induced erosion and sediment/soil transport and associated contaminants in the face of storm surge, tidal influence, extreme precipitation, sea-level change, and other extreme and climate-related events.

The research to date has already helped improve the understanding of contaminant sediment distribution dynamics as they relate to extreme weather events. NJDEP anticipates using future findings to develop a conceptual site model and to further assist coastal community resilience planning. Overall, this project can support EPA Region 2 and NJDEP in their design of ecological risk assessments and in NJDEP's planning for and responding to catastrophic events at contaminated sites.

Partners: New Mexico Environment Department (NMED), New Mexico Tech, University of Iowa, and Ohio State University
Challenge: Environmental sampling and assessment of local waterways and sediments following Gold King Mine Spill
Resource: Center for Native American Environmental Health Equity Research
Project Period: 2015 – Present

"ORD's support of the Center for Native American Environmental Health Equity Research has helped NMED reach out to and coordinate with Navajo Nation communities that were affected by the Gold King Mine spill." – NMED, Chief Scientist Dennis McQuillan

In 2015, about 3 million gallons of contaminated wastewater from the Gold King Mine spilled into the Animas River impacting several tribes and states. Following the spill, a team of researchers from the University of New Mexico Center for Native Environmental Health Equity Research and New Mexico Tech, in collaboration with the New Mexico Environment Department (NMED), performed a sampling trip collecting water and sediment samples from Silverton, CO to Farmington, NM. The results obtained from this work were presented at the Environmental Conditions of the Animas and San Juan Watersheds conference (Farmington, NM; May 17-18, 2016) which was co-organized by their collaborator from NMED and other staff from the New Mexico Water Resources Institute and institutions from the state of New Mexico.

As a result of this work, the Center, in collaboration with NMED, the University of Iowa, and The Ohio State University, initiated an investigation of the mineral phases and metal release by microbiological activity from sediments collected along the Animas River after the spill which impacted the Navajo Nation. Additionally, NMED has utilized the information generated by the Center to propose a long-term monitoring program that has been partially funded by EPA.

- Post Gold King Mine Spill Investigation of Metal Stability in Water and Sediments of the Animas River Watershed (published 2016)
- Gold King Mine Water Spill Long-Term Monitoring Plan (published 2017)

The EPA ORD-supported Center for Native American Environmental Health Equity Research, jointly funded by EPA and NIH, was established to address pervasive environmental health disparities. The Center's primary focus is biomedical and environmental research and Native-focused community engagement. The research team aims to expand their understanding of mixed-metal toxicity and enhance confidence in the characteristics of the metal exposures and the populations that influence the generalizability of the results.

Partner: South Carolina Department of Health and Environmental Control (SC DHEC)
Challenge: Developing and piloting effective strategies to target and treat subsurface chlorinated solvent contamination in zones containing numerous subsurface impediments
Resource: Pilot study including design, construction, and deployment of in-situ chemical oxidation (ISCO) technology in collaboration with the U.S. Marine Corps and the U.S. Navy
Project Period: 2012 – 2017

"Contaminated groundwater poses significant challenges to states. Development of new and innovative ways to treat it in situ is extraordinarily beneficial. We appreciate the availability of ORD expertise to partner with our state experts on this project, and we look forward to future opportunities to engage in collaborative problem-solving work." – SC DHEC, Director of Environmental Affairs Myra Reece

EPA ORD is collaborating with multiple agencies to produce a pilot-scale demonstration of in-situ chemical oxidation (ISCO) technology at the U.S. Marine Corp Recruit Depot in Parris Island, SC.

Spills and leaks of perchloroethylene (PCE), a colorless liquid widely used in the dry cleaning of fabrics, leaked into sanitary sewers resulting in groundwater contamination that is threatening nearby wetlands. The site is underlain by numerous utilities (high pressure water main, high voltage power line, communication line, sanitary and storm sewers, overhead steam lines) and involves high pedestrian and automobile traffic. Rigorous site characterization was used to develop an accurate site conceptual model using an array of aquifer cores and micro-wells to sample groundwater. Relative to conventional groundwater monitoring, more than 60% of the aquifer requiring ISCO was eliminated due to the development of an accurate conceptual site model.

ORD designed, built and deployed a portable, multi-arm, low cost and efficient oxidant injection system. The injection strategy optimized oxidant delivery and distribution in high priority targeted zones. Rigorous monitoring of PCE and the sodium permanganate oxidant helped to focus subsequent injections and to assure hydraulic control of the oxidant. ISCO has been selected by the partnering team for remediation at the site, and recommendations have been provided for design and deployment of full-scale remediation.

Read the final report titled *Pilot-Scale Demonstration of In-Situ Chemical Oxidation Involving Chlorinated Volatile Organic Compounds - Design and Deployment Guidelines (Parris Island, SC, U.S. Marine Corp Recruit Depot, Site 45 Pilot Study)* (published 2017).

Partner: Washington State Department of Ecology
Challenge: Upper Columbia River contaminated site
Resource: Technical support for remedial investigation/feasibility study
Project Period: 2018 – Present

"Washington is addressing surface soil legacy smelter-emission impacts across a range of communities and settings spanning the state. The assessment of state-of-the-art, minimally disruptive exposure reduction surface treatment technologies for rural-residential and rural tribal-use settings common to the upper Columbia River Valley is a fundamental step toward identifying long- term cleanup measures. ORD's participation is highly valued to ensure honest assessment, input and multi-disciplinary scientific oversight." – Washington State Department of Ecology, Toxics Cleanup Program, Upper Columbia River Site Project Coordinator John Roland

EPA ORD, in coordination with Region 10 (Pacific Northwest), is providing technical support for the Upper Columbia River (UCR) Valley Superfund Site's remedial investigation/feasibility study. EPA ORD is a member of the UCR Soil Amendment Technologies Evaluation Study technical team established through the interaction of the Coleville Confederated Tribes, Washington State Department of Ecology, Teck Resources Limited, Ramboll Environ and EPA Region 10. EPA ORD is engaged as a third-party to provide an unbiased, scientific assessment of, and expertise on, soil amendment alternatives for soil lead and associated metals in the UCR area. Amendment alternatives being evaluated include phosphate, magnesium oxides, ECOBOND®, compost, biochar and other widely accepted treatment options for lead in soil.

EPA has provided input on potential alternative treatments for the site and provided input on testing that could be done to predict treatment suitability/effectiveness at the site. EPA ORD also participates in site meetings and teleconferences with the region, state and potentially responsible party to discuss the site soils and alternative soil remediation approaches.

For more information, go to the Upper Columbia River Remedial Investigation and Feasibility Study webpage. This project is wrapping up and a manuscript summarizing the results has been produced.

Partner: Idaho Department of Fish and Game (IDFG), Washington State Department of Ecology
Challenge: Development of a passive remediation alternative at the Bunker Hill Superfund Site (Lane Marsh)
Resource: Technical Investigation
Project Period: 2015 – Present

"Abundant natural resources and clean functioning ecosystems are highly valued by local and regional residents and a huge part of why we choose to live here. The IDFG is committed to restoring healthy and productive ecosystems in the lower basin. We are happy to have been able to support and partner with EPA ORD in the effort to find new, innovative, and cost-effective approaches to the wildland contamination problems we face there." – IDFG, Regional Wildlife Habitat Biologist David Leptich

"The Washington State Department of Ecology appreciates ORD's involvement in the Bunker Hill Superfund Site. The tools being developed by ORD will not only ensure that lakes and marshes receive appropriate cleanups and reduce contaminant transport into Washington, but also may assist us in determining the best remedial strategies at our own cleanup sites." – Washington State Department of Ecology Toxics Cleanup Program, Hydrogeologist Sandra Treccani

The Lower Coeur d'Alene River Basin in northern Idaho and eastern Washington is an active habitat for migratory birds (including the Canadian Tundra Swan) and part of the Bunker Hill Superfund Site, a former lead refining and smelting facility. Historical and ongoing transport of contaminated sediment to floodplains, marshes and side lakes from the Bunker Hill site has resulted in annual acute lead toxicity of migratory birds that utilize the surrounding wetlands for feeding during migration. The concentration of lead in some sediments is so elevated that acute effects of lead toxicity are seen within as little as a two-week period. The loss of bird life has also resulted in reduced use of the river basin for recreational activities. The historical release of contaminated materials has led to the contamination of more than 18,000 acres of prime water fowl habitat. The size and scope of the sediment contamination prohibits the use and application of traditional remediation practices at this site, including sediment removal. A passive treatment option that reduces the potential for biological uptake of lead is required. EPA ORD is collaborating with state partners to develop a passive soil amendment option that would reduce bioaccessible lead concentrations in wildlife.

EPA ORD in collaboration with Region 10 (Pacific Northwest) have conducted an initial site investigation to evaluate geochemical cycles, contaminant distribution and chemical speciation of lead throughout Lane Marsh. This information was used to develop laboratory conditions for bench scale studies evaluating the performance of sediment amendments to reduce lead bioavailability. Research is ongoing as scientists begin selecting specific materials for field trials.

ORD's partners will use the results of the bench scale testing and field trials to determine the best options for passive remediation efforts. In addition, the potential for remedy selection based upon existing geochemical properties and contaminant speciation will be employed at other locations within the Lower Coeur d'Alene Basin. Successful identification and deployment of affordable and effective passive sediment remediation technologies will ultimately result in a reduction of bioavailable lead improving the ecosystem by protecting migratory birds and subsequently revitalizing recreational activities in the Lower Basin.

More information can be found on the Bunker Hill Superfund Site profile.

Partners: Florida Department of Environmental Protection, Georgia Environmental Protection Division, Kentucky Department of Environmental Protection, North Carolina Department of Environmental Quality, South Carolina Department of Health and Environmental Control and Tennessee Department of Environment and Conservation
Challenge: Characterizing urban background levels for contaminated site cleanup levels
Resource: Sampling protocol
Project Period: 2015 – 2016

"Having a data set like the one gathered during the urban background study is invaluable. It is very helpful to now have a comprehensive data set that we can use to make scientific determinations regarding appropriate urban background concentrations for many constituents."– Tennessee Department of Environment and Conservation, Environmental Consultant Merrie Embry, in the Memphis Environmental Field Office, who also noted that the benefit of working with EPA ORD and the other Southeastern states has helped to ensure consistency in their sampling approach and data evaluation.

In 2015, EPA scientists partnered with several Region 4 (Southeast) states to figure out how urban background contaminants differ from industrial waste at urban sites. Initial efforts were focused on creating a process for both soil sample collection and analysis that could be consistently applied across southeastern cities.

Soil samples collected from Louisville, KY; Lexington, KY; Memphis, TN; Raleigh, NC; and Winston-Salem, NC, were analyzed in EPA laboratories and added to a growing urban background database for metals and PAHs. The data and sampling process can be used by EPA, state agencies and local authorities to assess hazardous waste and brownfield sites and make decisions around cleanup. The database will provide a general range of urban background contaminant levels to be expected from sites in Region 4 cities. It can also serve as a screening tool for comparison of potential sites. The utility of the tool is improved as coverage of data for comparison over broader areas increases and more urban background data are added.

The success of the project has allowed sampling efforts to expand to additional cities in Tennessee, Georgia and Florida. Recently, EPA and the state of Tennessee have used the study protocol to conduct an urban background sampling effort in Chattanooga, TN. Additional regions, states, and universities, including Georgia State University in Atlanta, have expressed interest in the results and established sampling process. Professors and students at the University of Florida in Gainesville have already used the sampling process in two urban areas in central Florida.

More information on the Regional Urban Background Study.

Access the presentation materials from the EPA Tools & Resources webinar on the Urban Background Study.

Partner: Interstate Technology and Regulatory Council (ITRC)
Challenge: Need for specialized technical and risk assessment training
Resource: ITRC online training webinars and in-person training
Project Period: 2015 – Present

"The experience and knowledge of EPA scientists were essential to the success of this important training used by state risk assessors and others to address complex challenges at contaminated sites." – California Department of Toxic Substances Control, Senior Toxicologist Claudio Sorrentino

"The ITRC risk training is more robust as a result of our partnership with EPA experts on this effort." – South Dakota Department of Environment and Natural Resources, Engineering Specialist John McVey

In 2015, EPA ORD partnered with ITRC, a program of the Environmental Research Institute of the States, to develop specialized training for state risk assessors responsible for the cleanup of chemicals released into the environment. Based on feedback from EPA's Risk Assessment and Training Experience (RATE) program, ORD scientists reached out to ITRC and proposed that ITRC create training modules on the harmonization of risk assessment approaches across state regulators. EPA experts provided materials developed for its RATE program for the ITRC effort. These materials provide up-to-date and comprehensive training for human health risk assessment, ranging from beginner to expert classes.

The ITRC team of approximately 75 representatives from various environmental sectors completed a comprehensive web-based training module entitled, *Decision Making at Contaminated Sites: Issues and Options in Human Health Risk Assessment*. ORD scientists provided expert technical support as needed along the development processes and extensive peer reviews before release of the final product. More than 2,700 people have taken the online course and the associated guidance document is available to download.

A continuing partner with EPA ORD, ITRC has developed numerous documents and training over the last year. Within the last year, ITRC has published six technical guidance documents, ranging from traditional remedial topics (Hydrocarbons Site Management) to emerging contaminants (Microplastics, PFAS) and Environmental Data Management. ORD scientists participate on ITRC technical teams in both the development and review of ITRC products. ITRC is continuing to expand its training program in 2023, with over 20 internet-based training courses scheduled so far, including new courses on Environmental Data Management and Microplastics.

WASTE AND MATERIALS MANAGEMENT

Partner: Ohio Environmental Protection Agency (EPA)
Challenge: Elevated temperatures at a municipal landfill
Resource: Ongoing site visits, reports and technical expertise
Project Period: 2022 – Present

"EPA's Office of Research and Development (ORD) has reviewed numerous documents and visited elevated temperature landfills with our staff. Ohio EPA appreciates the expertise provided by ORD to support the technical review of the landfill operator's request to continue filling activities in the affected area." – Ohio EPA Environmental Manager Michelle Ackenhausen

Elevated temperature landfills are municipal solid waste (MSW) landfills that have experienced unusual subsurface reactions that raise the internal temperature and produce odorous landfill gas. The temperatures are usually above regulatory thresholds and can negatively affect the normal biodegradation process, and so they require additional monitoring to ensure the reaction does not spread or increase in intensity without notice. The odors are a nuisance to neighbors, and the wastewater the reactions generate is more difficult and expensive to treat. Therefore, both landfill operators and regulators must spend more time monitoring these areas to ensure protection of human health and the environment.

EPA ORD provided advisory assistance to Ohio EPA during a joint visit to an elevated temperature landfill where the management company proposed to continue and expand operations in previously capped areas that had reverted to normal temperatures. If approved, this would be the first time that a landfill would be allowed to resume normal disposal practices in a previously impacted area. The operator proposed a 10-month pilot study on a small portion of the total affected area. ORD and Ohio EPA posed questions to the operator, made comments about the proposal, and suggested items for future discussion. ORD plans to continue assisting Ohio EPA as the operator's revised plans are reviewed.

Partner: Rural Alaskan Communities via Solid Waste Alaska Taskforce
Challenge: Helping Alaska villages prevent contamination by efficiently backhauling waste
Resource: EPA developed an iOS application that collects live tracking data to ship waste from rural communities to final disposal destinations
Project Period: 2020 – Present

"It is our hope that the work here can be applied to situations that other underserved communities of need face, multiplying the benefits of this outstanding partnership." – Zender Environmental Health and Research Group, Executive Director Lynn Zender

Under a unique exception to the Resource Conservation and Recovery Act, many rural Alaska communities rely on unlined landfills to dispose of waste due to their remote locations. This approach is not appropriate for discarding hazardous waste, which can pose health and environmental risks when improperly disposed. Therefore, the waste must be transported long-distance to recycling destinations, a task that is often both expensive and logistically difficult. Over the past five years, EPA Region 10 (Pacific Northwest) has partnered with the Solid Waste Alaska Taskforce (SWAT), a joint collaboration between the state of Alaska, Alaska Native Tribal Health Consortium, Kawerak Inc, and Zender Environmental Health and Research Group, to develop a household hazardous waste backhaul service program, called Backhaul Alaska, to serve 160 communities located off of the national highway system.

In March 2020, EPA ORD in collaboration with Region 10, was requested to support the Backhaul Alaska Program's logistical efforts. The program was started as a pilot among 25 communities who needed a technology capable of scaling up the service statewide. One of the lingering challenges in the program was to develop a tool capable of supporting the removal of hazardous waste from rural Alaska. The tool would be used by communities in rural Alaska to log hazardous waste inventories in harsh environmental conditions. Central to all of this is tracking the materials—where they are from, where they are going, how they are packaged, how much of each type there are, and multiple other features. ORD used its prior experience developing similar tools for post-disaster events to quickly identify viable options for managing transportation and recycling logistics.

Within a few months, researchers adapted an ESRI ArcGIS Survey123 program by adding a barcode creator and interactive dashboard to integrate with the program's inventory management and control procedures. SWAT is implementing the tool across more than 16 different communities, collecting initial inventories, and garnering feedback from participants in the field. In turn, EPA ORD is using this feedback to refine the application for its use in the upcoming backhaul events in spring and summer 2021.

EPA ORD is currently developing a user-centered design application to support the program through the Regional State/Tribal Innovation Project, a collaboration with Region 10. This collaborative effort will ultimately help rural Alaska communities prevent contamination of their environment and subsistence resources in a financially feasible way.

Partner: California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA)
Challenge: Addressing safety concerns of tire crumb rubber used in synthetic turf fields and playgrounds
Resource: Research for improved exposure assessment in collaboration with the Centers for Disease Control and Prevention (CDC) and the U.S. Consumer Products Safety Commission (CPSC)
Project Period: 2016 – Present

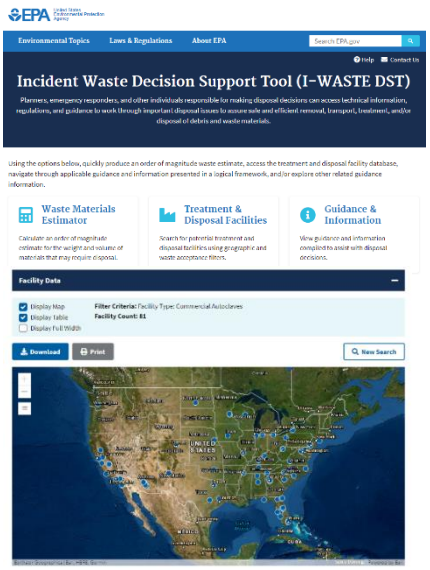
"The U.S. EPA study complements and strengthens what we are doing in California. Consultations with the U.S. EPA scientists benefit our project team and help to improve the quality of the California synthetic turf study."
– CalEPA OEHHA Senior Toxicologist Patty Wong, PhD

EPA ORD is collaborating with the CDC's National Center for Environmental Health and Agency for Toxic Substances and Disease Registry (ATSDR) and the CPSC to study key environmental and human health questions. To address the concerns that have been raised about the potential health risks from playing on synthetic turf fields containing tire crumb rubber, a Federal Research Action Plan was launched in 2016 to investigate potential human health implications. The Federal Research Action Plan has four parts: a literature review and data gaps analysis, outreach with key stakeholders, tire crumb rubber characterization research, and human exposure characterization research. This research will provide a better understanding of the chemicals found in tire crumb rubber and the potential exposures that field users may experience by using these fields.

EPA and CDC/ATSDR are reporting research findings in two parts. Part 1 communicates the research objectives, methods, results and findings for the tire crumb rubber characterization research (i.e., what is in the material). This report is now available. Part 2, to be released later, will include data to characterize potential human exposures to the chemicals found in the tire crumb rubber material while using synthetic turf fields. Part 2 will be released along with results from a biomonitoring study being conducted by CDC/ATSDR to investigate potential exposure to constituents in tire crumb rubber infill. CPSC is conducting separate research on playgrounds. These research activities and the resulting findings do not provide an assessment of the risks associated with playing on or contact with the recycled tire crumb rubber used for synthetic turf fields. Instead, these research results should inform future risk assessments.

Researchers at CalEPA OEHHA are also conducting research aimed at reducing data gaps for tire crumb rubber constituents and human exposures. The federal research team regularly consults with OEHHA scientists to discuss how the two studies can be mutually informative. Information is shared between EPA and OEHHA through a Materials Cooperative Research and Development Agreement (MCRADA). The federal and state researchers have implemented methods and approaches that will, where feasible, produce comparable data. This could effectively expand the overall U.S. research sample size and will provide additional insight into potential exposure variability. There are also important differences between the federal and OEHHA studies that will provide complementary data for improved exposure assessment. EPA and OEHHA research staff have also jointly participated in sessions on tire crumb research at several international scientific conferences including the 2018 International Society of Exposure Science (ISES)-International Society for Environmental Epidemiology (ISEE) Ancillary Workshop on *Translating Research on Recycled Tire Crumb Rubber: Opportunities for International Cooperation* in Ottawa, Canada.

Partners: State environmental agencies (CA, NC, NY, SC)
Challenge: Large volumes of post-disaster waste
Resource: I-WASTE tool used to estimate type and volume of waste materials
Project Period: 2018 – 2019



"I-Waste can be valuable addition to the debris management toolbox, and DEQ would encourage local governments and other entities involved in the planning and response to disasters to determine if it can be of benefit to their communities or organizations." – NC DEQ former Assistant Secretary for Environment Sheila Holman

Natural disasters generate large volumes of waste each year as seen by recent hurricanes Florence and Irma. In addition, large scale events involving chemical, biological, or radiological contamination, as well as animal disease outbreaks, have the potential to exponentially increase the burden of waste over a short period of time. Effective and timely management of contaminated materials is critical for protecting and restoring communities and the environment. Understanding the type of waste that might be generated in an incident and having information on treatment and disposal methods can greatly reduce cleanup costs and shorten remediation timelines.

EPA's Incident Waste Decision Support Tool (I-WASTE) provides a wealth of such information, including the types and volumes of waste materials and potential contaminants generated during an incident; the location and contact information for potential treatment/disposal facilities; and health and safety information important during the removal, transport, treatment and disposal of contaminated waste and debris. The tool helps decision makers understand the impact of waste-generating decisions before, during and after an event and how they are closely tied to decontamination decisions. New York State Department of Environmental Conservation's Dr. Alan Woodard was instrumental in the development of I-WASTE; his input has been critical to the interface, content, and future development efforts of the tool as it has evolved over the years.

EPA's I-WASTE tool has been used in multiple events since its development, including floods and fires in Idaho, carcass disposal following a highly pathogenic avian influenza outbreak, during response efforts for the Ebola virus, and multiple hurricanes. In 2019, EPA ORD used the tool to identify potential disposal facilities in California following a ricin incident at Pelican Bay State Prison outside of Crescent City, Del Norte County. Prior to Hurricane Florence hitting North Carolina, South Carolina, and Virginia in 2018, the I-WASTE tool was used to identify waste management facilities that may be adversely impacted by the storm, as well as facilities that could serve as potential recipients for hurricane-generated debris. This helped local communities plan where they would transport the waste and identify alternative locations if their primary landfills were flooded or impacted. I-WASTE has recently added additions to its treatment and disposal facilities databases to address the treatment and disposal of perfluorinated alkyl substances (PFAS). I-WASTE has recently been migrated to cloud.gov for hosting. This new version of I-WASTE no longer requires a username to access the tool, and it includes Application Programming Interface (API) functionality so other tools (e.g., OLEM's All Hazards Waste Management Planning Tool) can directly access I-WASTE's waste material estimator and facility databases.

Partners: South Carolina Department of Health and Environmental Control (SC DHEC), South Carolina Department of Commerce (Commerce), and the City of Columbia (SC)
Challenge: Food waste reduction and landfill diversion
Resource: Food Waste Tracker Technology in collaboration with the U.S. Army (Fort Jackson)
Project Period: 2014 – 2017

"EPA ORD's proposal of the LeanPath demonstration came at an optimal time for Fort Jackson. In the installation's efforts to meet Net Zero Waste initiatives, we have explored ways to divert solid waste from the landfill via off-site composting and food donations. With the implementation of the LeanPath scales, we are able to collect data that support these measures. Additionally, there is the opportunity to critically assess our dining operations and identify ways to improve operations and make fiscally-sound decisions. EPA ORD has been very engaging and more than helpful during the demonstration." – U.S. Army Garrison Fort Jackson DPW-Environmental Division, Senior Project Manager Tameria Warren

The U.S. Department of Agriculture estimates that one out of six people struggle with hunger in the United States, yet food waste is the single largest component being sent to landfills and accounted for 21 percent (35.2 million tons) of the nation's waste in 2013. South Carolina alone produced an estimated 607,000 tons of food waste in 2015.

In 2014, EPA ORD researchers with the Net Zero program initiated a partnership with SC DHEC, SC Commerce and the U.S. Army to better manage organic waste in the Columbia region. EPA's Net Zero partnerships work with communities and military installations to develop and apply innovative approaches to reduce energy, landfill waste and water use. Collaborators in this partnership included representatives who work on waste management issues from local businesses, municipal officials, non-governmental organizations, and the Fort Jackson Army base. Partners shared ideas and best practices through conferences and face-to-face meetings. EPA also conducted a feasibility study that recommended strategies for optimizing recycling, repurposing, and recovery of organic materials in the region. Since the partnership was created, South Carolina launched several educational and food waste diversion campaigns, including the "Don't Waste Food SC" statewide campaign.

In March 2017, EPA provided technical expertise, community outreach and funding to conduct a technology demonstration study using the *LeanPath 360* food waste prevention technology at the Fort Jackson Army base – one of the largest military training installations in the nation. LeanPath is an automated food waste tracking system that helps companies and organizations reduce food waste. The project resulted in over 5 tons of food being diverted from the landfill and donated to SC food donation and composting programs. The emphasis on using environmental science as a solution for local hunger problems as well as mitigating costs, landfill use, and associated emissions is what makes this project truly special. The full project report can be found here. This work had a direct positive impact on regional environmental quality, reduced the Army's costs for food procurement and landfill tipping fees, and improved quality of life for disadvantaged Columbia residents. Although the project has finished, the base has continued to donate unused food from these two dining facilities, and they are considering expanding the donation program to two additional facilities.

The project attracted recognition and praise from DoD partners. The food donation achievements were featured in the base newspaper, *The Leader,* and were highlighted during local television news coverage of the Fort. Other DoD installations have reached out to the Net Zero team signaling interest in this approach and seeking guidance on how to replicate it.

WATER – DRINKING WATER

Partners: Michigan Department of Environment, Great Lakes, and Energy (EGLE), Michigan Department of Health and Human Services (DHHS)
Challenge: Helping Benton Harbor residents know the importance of using water filters to reduce lead in their drinking water
Resource: Field research and technical support
Project Period: 2021

"The results of EPA's Benton Harbor filter study were a key component in informing the public health on what steps they could take to protect their families from lead in drinking water." – Michigan EGLE Director Liesl Clark

In the fall of 2021, the state of Michigan was responding to a continuing challenge of increased levels of lead, which is toxic to humans, in the city of Benton Harbor's water system. In response, the Michigan DHHS began providing the Berrien County Health Department with water filters to distribute to residents of the city. Two types of filters were distributed—pitchers and faucet-mounted, point-of-use (POU). Both types were certified by NSF/ANSI 53 for lead reduction to reduce the level of lead in tap water.

To support the state's response and to address concerns raised in a Safe Drinking Water Act petition filed on behalf of the residents of Benton Harbor, EPA's Office of Water requested that ORD conduct a filter effectiveness study. EPA ORD researchers designed the study to address two major concerns: 1) lead levels in some residences exceeded the certified capacity of the filters, 150 parts per billion (ppb), and 2) lead nanoparticles small enough to pass through the filters might be forming in the water.

ORD scientists worked closely with EPA Region 5 (Midwest), Michigan EGLE and Michigan DHHS to develop a drinking water sampling protocol to evaluate NSF/ANSI 53 certified water filters in the city of Benton Harbor. They also collected additional water samples to identify lead sources in the community and determine if lead nanoparticles were forming.

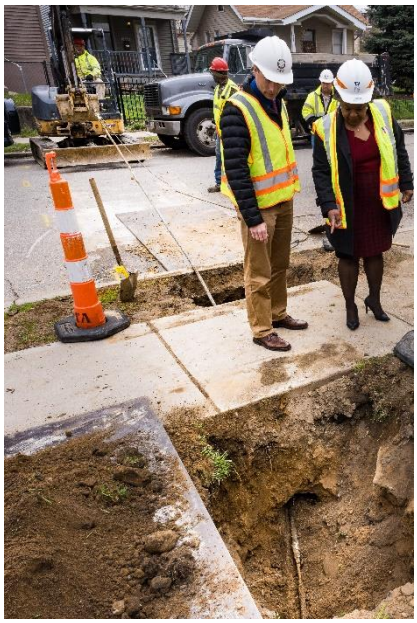
A joint team of representatives from ORD, EPA Region 5, Michigan EGLE and DHHS was rapidly deployed to the city to conduct door-to-door water sampling, water filter installation, and education. The team initially operated out of Benton Harbor's water treatment plant and later moved to one of the local community colleges. The team worked with local organizations to identify residences to be sampled. From November 9 to December 17, 2021, EPA was on the ground in Benton Harbor collecting and couriering water samples to EPA's Chicago Regional Laboratory where they were analyzed for lead and other water quality parameters.

A total of 307 properly operated and certified filtered water samples (from 199 locations) were collected and 100% of the filters performed as they were certified, meaning that all filtered water samples had lead concentrations of 5 ppb or less. Ninety percent of the filtered water samples were below the 0.5 ppb laboratory reporting limit for lead, and none of the filtered water samples contained lead greater than 2.5 ppb. These results confirmed that the filters are effective in removing lead in Benton Harbor drinking water.

The information that ORD provided was crucial for helping Michigan EGLE and DHHS make decisions and provide citizens with the best possible information about the importance of using certified filters to reduce lead concentrations in their drinking water to protect themselves and their families. This rapid and comprehensive response to local and state concerns is a reflection of EPA's commitment to ensuring that everyone has access to clean drinking water.

EPA continues to support the Benton Harbor public water system and Michigan state agencies to ensure access to safe drinking water for the Benton Harbor community, and more information about this response can be found here: https://www.epa.gov/mi/benton-harbor-drinking-water.

Partner: Illinois EPA, City of Galesburg (IL)
Challenge: High lead levels found in drinking water due to lead service lines
Resource: Lead service line identification project and technical support, in collaboration with Battelle
Project Period: 2014 – 2017



"The Illinois EPA was very pleased that Galesburg volunteered to participate in ORD's lead service line identification project. We are very hopeful that this project will go a long way in assisting water suppliers who are unsure of the material types of the plumbing connected to their distribution systems. Ultimately, the Illinois EPA hopes that this lead service line identification project, combined with other research being conducted by ORD, will provide low-cost alternatives to digging to determine service line material types."
– Illinois EPA, Bureau of Water, Division of Public Water Supplies Manager W. David McMillan

EPA ORD worked with the City of Galesburg, Illinois EPA, and EPA Region 5 (Midwest) on lead service line (LSL) identification project in Galesburg. The LSL identification project, led by ORD and its contractor Battelle, was initiated as part of the Flint response to address the national issue of helping water distribution utilities and individuals locate LSLs. Galesburg has implemented phosphate-based corrosion control treatment to reduce lead levels in the distribution system and provided public education while actively replacing LSLs throughout the city.

During the week of July 31, 2017, Battelle collected sequential samples from 12 homes in Galesburg. On August 10, 2017, the project team received the first round of sampling results from the EPA Region 5 lab. The results indicated elevated lead levels at some locations.

EPA developed notification language that was sent to the City of Galesburg via email on August 11 to inform them of the sampling results and to recommend use and/or installation of point-of-use filtration devices. The LSL identification project also includes a past sampling effort in Flint, MI.

Partners: Michigan Department of Environment, Great Lakes, and Energy (EGLE); City of Flint (MI)
Challenge: High lead levels and other water quality challenges in the Flint water system
Resource: Technical support, computer modeling and sampling equipment
Project Period: 2016 – 2018

"The information that our EPA colleagues shared was critical to our understanding of water systems in Flint." – Genesee County Health Department, Public Health Division Director Suzanne Cupal, MPH

In April 2014, the City of Flint, Michigan, switched from purchasing finished drinking water from the City of Detroit to treating raw water from the Flint River. For several reasons, the finished drinking water was corrosive following this change. As a result, the water stripped the protective mineral layer from pipes in the drinking water system and caused lead to leach from the pipes, increasing the lead levels in the water. In October 2015, Flint switched back to purchasing finished water from Detroit, and EPA formed the Flint Drinking Water Technical Support Team to provide technical assistance to the city and state. In January 2016, EPA started a large-scale sampling effort in Flint for lead, water quality parameters, and chlorine residual throughout the distribution system.

EPA ORD scientists and engineers, in coordination with EPA Region 5 and the Office of Water, provided technical support for the Flint drinking water response effort and the Flint Drinking Water Technical Support Team. The Technical Support Team provided technical assistance to Michigan EGLE and the City of Flint to inform decisions about a source of drinking water and to optimize corrosion control for the Flint system. EPA researchers reviewed the treatment history, corrosion control and water quality for the Flint water system and made treatment recommendations. They also provided sampling equipment and advice in the field on sampling strategies and developed a disinfectant residual monitoring plan to ensure that residual is maintained throughout the distribution system. In addition, an improved distribution system hydraulic model was built so the city now has a better understanding of the quality of the water moving through the system. To further understand these issues across the country, EPA ORD built and transported to Flint a pipe loop pilot system to study lead-containing scales on lead service lines taken from Flint homes. This system allowed Flint to identify optimum water quality and treatment conditions to prevent lead release and safeguard public health. This system has been, and can be used, in other communities to help with corrosion issues.

ORD researchers further supported the City of Flint with guidance on multiple issues over the last few years, providing expert opinions on drinking water issues and supporting Flints efforts developing lead service line detection methodologies for identifying existing lead pipes, lead particle analysis and assessment, corrosion control treatment optimization studies for water source change using pipe rigs, lead source/release diagnostic studies, and pipe analyses for long-term treatment assessment and mechanisms of lead and other metals release.

Additional information on the Flint Drinking Water Technical Support Team's activities.

Relevant Journal Articles:

- Design and Testing of USEPA's Flint Pipe Rig for Corrosion Control Evaluation
- POU Water Filters Effectively Reduce Lead in Drinking Water: A Demonstration Field Study in Flint, Michigan
- Sequential Drinking Water Sampling as a Tool for Evaluating Lead in Flint, Michigan
- Water quality-pipe deposit relationships in Midwestern lead pipes

Partners: City of Poughkeepsie, NY and U.S. Virgin Islands Water and Power Authority
Challenge: Assessing Resilience of Drinking Water Systems to Natural Disaster
Resource: Water Network Tool for Resilience (WNTR)
Project Period: 2017 – 2022

Figure 1: Damage following earthquake, including broken pipes.

"In 2017 EPA researchers conducted a computer modeling of our water usage to determine impact of supply deficiencies and distribution breaks. Their effort was instrumental in showing our Water Board where our risks are and was valuable in preparation of budget to address concerns identified." – Poughkeepsie Water Treatment Facility, Plant Administrator Randy Alstadt

The prototype Water Network Tool for Resilience (WNTR) is an open-source resource designed to analyze a wide range of water distribution network failure and recovery scenarios and help users prioritize resilience enhancing actions. It can be used to estimate potential damage, understand how infrastructure damage would occur over time, evaluate preparedness strategies, prioritize response actions, and identify worst case scenarios, efficient repair strategies, and best practices for maintenance and operations. EPA researchers and EPA Region 2 are collaborating with partners on two case studies to use WNTR to advance resiliency—one with the City and Town of Poughkeepsie, NY, and the other with the U.S. Virgin Islands (USVI) Water and Power Authority.

In 2017, EPA researchers and partners began working with the City and Town of Poughkeepsie, NY, to investigate the resilience of their drinking water system. Using WNTR, they assessed a scenario involving the loss of source water to their treatment plant due to frozen intake pipes, drought, saltwater intrusion, or other events. Water utility decision makers were interested in evaluating how long they could supply water and what approaches, such as reducing usage, could effectively extend that timeframe. Researchers also assisted Poughkeepsie with analyzing how breaks in critical distribution pipes could affect firefighting capability. The resulting analysis was shared with the city, who proposed to use the results to plan for and justify the costs of system upgrades that would enhance resilience over the long-term.

In May 2020, the Naval Postgraduate School (NPS) approached EPA to partner in their resilience study of the USVI Water and Power Authority (WAPA), which supplies drinking water to the St. Croix, St. Thomas, and St. John islands. Using WNTR, EPA ORD researchers simulated four-week power outage scenarios, similar to those caused by hurricanes. NPS brings expertise in electrical power resilience, and together we are addressing interdependencies between water and power systems. The results will be used by the utility to develop a hazard mitigation and resilience plan to address future hurricanes. Information from the analyses was shared with the utilities and journal articles detailing the approach have been developed. These community applications demonstrate how WNTR can be used to identify utility vulnerabilities and offer specific resilience improvements to match different disaster scenarios, as well as structure capital investment plans.

Partners: Ohio Environmental Protection Agency (EPA) and public water utilities along Lake Erie
Challenge: Managing algal toxins in drinking water treatment plants
Resource: Algal toxin and water quality studies at drinking water treatment plants using Lake Erie as their source
Project Period: 2013 – 2014

"Ohio and EPA ORD continue to lead the nation in working with public water systems to ensure safe drinking water and minimize the threat of harmful algal blooms (HABs) and other emerging contaminants. Research that EPA ORD is doing is providing Ohio with immediate and practical information as we implement first in the nation rules on HABs, and we are grateful and fortunate and thankful for the collaboration on these important issues." – Ohio EPA, Craig Butler (former Director)

Increasingly, drinking water treatment plants are challenged by changes in the quality of their source waters and their often-aging treatment and distribution system infrastructure. Individually or in combination, factors such as, climate change, agricultural runoff, and landscape development increase the probability that harmful algal blooms will occur, and that algal toxins will break through treatment barriers and end up in drinking water.

In cooperation with public water utilities along Lake Erie, EPA ORD conducted studies to improve our understanding of cyanobacterial toxin propagation through the drinking water treatment process, and to identify the best approaches for removing them. The recent sampling campaign provided a unique opportunity to characterize the impact of Lake Erie's cyanobacterial bloom and its associated toxins on drinking water treatment facilities at a high level of analytical detail. Researchers were able to provide utilities and regulators with treatment recommendations that will help them make better informed long-term decisions regarding the operation and modification of treatment processes to optimize removals.

Partners: Ohio Environmental Protection Agency (EPA) and the City of Toledo
Challenge: Harmful algal bloom preventing access to drinking water
Resource: Drinking water testing to help restore drinking water availability
Project Period: 2014

"When we were faced with an emergency in Toledo, August 2014, due to cyanobacterial toxins detected in their treated drinking water, EPA ORD staff was a great partner and exceeded our expectations in understanding science and helping optimize treatment and restore safe drinking water to our residents." – Ohio EPA, Craig Butler (former Director)

On August 2, 2014, the Mayor of Toledo, Ohio, issued a "Do Not Drink" order for the 500,000 people of the City of Toledo and neighboring communities because the water utility detected microcystin, a cyanobacterial toxin, in the finished drinking water. The City's drinking water source, Lake Erie, was experiencing a large cyanobacterial bloom at the time, and microcystin was the primary toxin detected. Microcystin is resistant to high temperatures so a "boil water" advisory would not have been effective. The water ban set in motion a number of emergency actions, including Ohio Governor John Kasich declaring an emergency in the area, the mobilization of the Ohio National Guard to distribute bottled water, and the closure of hundreds of water dependent businesses in the Toledo metro area.

Working in conjunction with the City of Toledo, Ohio EPA officials immediately reached out to EPA ORD's Cincinnati-based research laboratory for technical assistance. This laboratory is known as a world leader in the evaluation and development of innovative drinking water testing, monitoring, and treatment technologies. Ohio EPA asked for assistance with laboratory analyses for the presence of cyanobacterial toxins in treated drinking water and identifying the optimal approach for controlling cyanobacterial toxins in the drinking water treatment plant and distribution system. EPA ORD assembled a team of scientists and engineers to work throughout the weekend. The ORD team led discussions regarding sample handling and procedures and facilitated an agreement between Ohio EPA and the City of Toledo as to how they would collect and handle samples. Samples were handled per the protocol, and chemical analyses were run by an agreed upon procedure between Ohio EPA, the City of Toledo and EPA. Following the initial set of samples, the City of Toledo collected additional water samples throughout their treatment plant to assess the effectiveness of various treatment processes in reducing the cyanotoxin concentrations. The ORD team assessed sample results as the analyses were completed and recommended treatment plant adjustments to further reduce cyanotoxin levels in the finished drinking water, and they communicated the issues to local and state officials in real time during the event.

ORD's efforts to produce timely and accurate results were critical for the Mayor of Toledo and the Governor of Ohio when making their decision to lift the "Do Not Drink" order two days later on August 4, restoring safe drinking water to some half a million people. Soon after the order was lifted, EPA's Office of Water consulted with the ORD team and Ohio EPA to identify the lessons learned from the Toledo incident, particularly with regard to the sample preservation and handling procedures for cyanotoxin samples, identifying areas where improved guidance could be provided to U.S. drinking water systems performing cyanotoxin monitoring to assure samples are appropriately preserved for transport and prepared for analysis.

Partners: Texas Commission on Environmental Quality (TCEQ), Texas Department of State Health Services (DSHS) and City of Corpus Christi
Challenge: Chemical contamination in Corpus Christi's water supply
Resources: Determine health risks and action level
Project Period: 2016

"The water situation in Corpus Christi in December 2016 was a good example of cooperation between Texas and EPA and the success we have when all work towards solving an environmental issue." – TCEQ, Bryan W. Shaw (former Chairman)

In December 2016, EPA ORD scientists, in coordination with Region 6 (South Central U.S.), responded to a request for assistance in Texas after an asphalt emulsifying agent, Indulin AA-86, contaminated Corpus Christi's water supply. Toxicity information along with treatment options to remove this chemical from water was lacking. ORD researchers provided assistance early in the response concerning decontamination approaches that might be suitable for use in removing the contaminant from the system. In addition, EPA helped dissect and understand the toxicity of the chemical and possible risks associated with ingestion of contaminated water and the water-soluble salt from the product. Texas state agencies, TCEQ and the Texas DSHS, along with ORD researchers and their colleagues across EPA worked together to establish a health-based action level for the contaminant and supported an immediate need to protect public health.

Partners: Iowa Department of Natural Resources (DNR), Illinois, Indiana and Ohio
Challenge: Ammonia found in drinking water in agricultural areas
Resource: Cost-effective treatment technologies for small drinking water systems with EPA licensed NoMoniaTM technology to reduce ammonia in drinking water, in collaboration with AdEdge Technologies (ChartWater™)
Project Period: 2014 – 2017

"Given the array of challenges faced by small drinking water systems, ORD's development of an affordable and easy to use ammonia treatment technology is very helpful to Iowa and many other states. Technical and research support of small drinking water systems is very important to Iowa." – Iowa DNR Environmental Services Division former Director Bill Ehm

Across the United States, ammonia is found at high levels in many agricultural areas where groundwater is the primary drinking water source, and it can be a significant source of nitrate within the pipes of drinking water distribution systems. When nitrate exceeds regulated levels, it poses significant health risks to infants, causing symptoms that include shortness of breath and blue baby syndrome. Ammonia can also compromise the effectiveness of conventional water treatments for removing arsenic and othercontaminants.

EPA ORD researchers developed a new, affordable and easy-to-use drinking water treatment system –now known to the world as Patent No. US 8, 029,674 and was marketed commercially by AdEdge Water Technologies (ChartWater™)under the trade name NoMoniaTM – for small drinking water systems. The innovative, low-cost technology uses naturally occurring microorganisms to remove ammonia, iron, manganese, and aresenic. It is a single treatment process that generates no hazardous waste.

NoMoniaTM was selected as the winner of the “Executive Board Technology Award” at the 2017 National Federal Laboratory Consortium. An announcement (April 2017) in Water Online notes that “The award highlights a successful technology transfer from a federal agency to a private sector company to commercialize, design, and market the aforementioned technology.”

Read the final report titled *Innovative Biological Treatment Process for the Removal of Ammonia, Arsenic, Iron and Manganese from a Small Drinking Water System in Gilbert, Iowa (Phase 1: Pilot Evaluation)*.

Access the presentation materials from the EPA Tools & Resources webinar on Cost-Effective Treatment Technologies for Small Drinking Water Systems.

Partners: Colorado, Florida, Kentucky, Michigan, and Ohio state environmental or health departments
Challenge: Simulating and monitoring conditions in drinking water utilities
Resources: Technical assistance and field support
Project Period: 2014 – 2018

"Having access to my operational data in real-time keeps me on top of the system performance even when I am not at the plant. This tool helps me manage my staff and resources by providing greater flexibility and real-time information." – Milford, OH, Water Department Supervisor Matt Newman

EPANET-RTX (real-time extension) and RTX:LINK are software tools that have helped states and their drinking water utilities by allowing continuous monitoring of their operations to improve water quality and respond to incidents. Together states and their utility partners use the tools to better understand and help improve drinking water system operations.

EPANET-RTX was developed to allow utilities to link their raw Supervisory Control and Data Acquisition (SCADA) data with their EPANET distribution system hydraulic model to evaluate conditions in the system in real time. The development of real-time analytics can provide utilities with the necessary tools to enhance system operations including emergency response and improved operations, e.g., better pressure management, leak detection and water quality. EPANET-RTX has been tested or demonstrated in several locations including Ohio, Colorado, Florida, Kentucky, and Michigan.

To make real-time monitoring available to small systems that lack powerful computing capability, RTX:LINK provides access to the SCADA data through mobile applications and desktop computers. RTX:LINK software provides simple and secure access to key water utility operational data streams, using web-based dashboards for trending and alerting. With RTX:LINK drinking water utilities have the ability to better understand water quality and operational conditions in their system at any point in time.

RTX:LINK software is easy to install on popular SCADA systems and has been tested in several locations. RTX:LINK was piloted in the Milford, Ohio, water system, where it has provided 24-hour access to current and historical tank levels, pump statuses and distribution system flows via mobile or desktop devices.

RTX:LINK was also tested in the city of Flint, Michigan, where it was used to provide the same benefits as those in Milford along with a continuous, real-time understanding of water age. Using this technology has helped these water systems better understand how to optimize operations, e.g., where and how to decrease water ages and identify low-pressure areas, and help predict available pressures for firefighting should disruptions occur in the distribution system.

Read the final report titled *Deployment of Real-Time Analytics and Modeling at the City of Flint, Michigan, Water* System.

Partners: Association of State Drinking Water Administrators (ASDWA) and other state contributors
Challenge: Providing information, technical assistance, and training to small drinking water systems
Resource: Webinars, workshops and workgroup to address challenges and treatment solutions for small systems
Project Period: 2003 – Present

"ASDWA is pleased to partner with EPA in the sharing of resources and organizing opportunities that bring together the drinking water sector. During an era of rapid regulatory movement, it is imperative for the advancement of public health protection that the water industry works in tandem to learn from each other and share ideas through our partnership that encompasses all levels of government." – ASDWA Senior Policy Analyst Kevin Letterly

EPA's ORD and Office of Water, in partnership with ASDWA, host a free annual workshop to provide in-depth information and training on various solutions and strategies for handling small drinking water system challenges. Because they tend to have fewer resources than larger systems, small systems can face enormous challenges in consistently providing safe and reliable drinking water. For 20 years, the workshop has brought together professionals from states and territories, Tribes, federal agencies, academia, NGOs, local agencies, system owners and operators, and others to share the latest information, resources, and training needed to help in building systems capacity and sustainably and with providing equitable access to drinking water. The 2022 workshop, held in person and virtually, attracted 260 in-person attendees and 1,300+ virtual attendees, including representatives of 4 Tribal Nations and of 92 state/territory agencies from 45 states, DC, and 1 U.S. territory. To optimize networking, increase engagement, and to promote a shared learning experience, the workshop will be held as an entirely in-person event in 2023. Register for the 20th annual workshop and access past workshop recordings.

As an extension of the annual workshop, EPA's ORD and Office of Water began hosting a monthly webinar series in 2015 that is targeted to state/territory agencies, Tribes, and water utilities on challenges and treatment solutions for small water systems. In 2022, the series attracted 9,100+ attendees, including representatives of 53 Tribal Nations and of 149 state/territory agencies from all 50 states, DC, and 2 U.S. territories. Presenters are typically from EPA and the states to help encourage communication between EPA and the states and between the states themselves. Beginning in 2023, ASDWA is now partnering with EPA on this series. Access the webinar series schedule, registration, and past recordings.

Both the workshop and webinar series allow EPA to communicate directly with the states to provide training, including continuing education contact hours, and foster collaboration and dissemination of information. This, in turn, provides them with information and resources needed to communicate the latest scientific advancements and current guidance to their small systems. These forums also provide EPA invaluable information on the problems that states are currently encountering in their day-to-day interactions with their small systems. With this increased awareness, ORD experts can then modify their research to solve real-world problems that small systems are experiencing.

WATER – NUTRIENTS

Partner: Interstate Technology & Regulatory Council (ITRC)
Challenge: Strategies for Preventing and Managing Cyanobacterial Blooms
Resources: Online Guidance Documents, web-based training, and educational video, Learn to Identify Cyanobacteria Blooms
Project Period: 2019 – 2023

"The HCBs Team is an ITRC success story demonstrating how state and federal agencies including EPA working with invested stakeholders and local governments can develop guidance on strategies and approaches to respond and manage an environmental impact. The training is delivered by multiple state agency representatives sharing experiences and knowledge to inform a larger audience about this growing freshwater impact." – H&M Environmental, LLC Nicole Henderson

Cyanobacteria are microscopic organisms that can produce toxins (cyanotoxins) that can cause illness or death in humans and animals. Harmful cyanobacterial blooms (HCBs) can also impair drinking water sources, recreational uses, fisheries, and property values. HCBs can occur in freshwater and marine environments and can be influenced by various factors such as nutrient loading, temperature, light, water flow, and climate change.

The ITRC HCB team has conducted extensive research and review of the current scientific literature and state-of-the-art practices for HCB prevention and management and created two guidance documents to help stakeholders prevent and manage HCBs in different aquatic settings. In 2021, ITRC published Strategies for Preventing and Managing Harmful Cyanobacterial Blooms (HCB-1), which focuses on strategies for planktonic HCBs, which are cyanobacteria that float in the water column. The second document, Strategies for Preventing and Managing Benthic Harmful Cyanobacterial Blooms (HCB-2), was published in 2022 and focuses on benthic HCBs, which are cyanobacteria that grow on the bottom or attached to surfaces. Both documents provide tools, guides, and other resources to help users select appropriate monitoring, field screening, sampling and analytical methods, laboratory testing, prevention and management strategies, communication, and nutrient reduction approaches for their water bodies.

The ITRC HCB team has also developed online training sessions to accompany the guidance documents. The training sessions review key information found in the two ITRC HCB guidance documents including an overview of the cyanobacteria biology, ecology, and toxicity, and the ITRC framework for HCB prevention and management. These sessions also demonstrate how to use the interactive tools and visual guides in the guidance documents and showcase examples of successful HCB projects from multiple states.

Partner: Chemehuevi Indian Tribe (CIT); Colorado River Indian Tribes (CRIT)
Challenge: Negative effects of harmful algal blooms (HABs) on the water quality of Lake Havasu
Resource: Collaborative pilot project to explore how native plants used in floating vegetated islands can help mitigate water quality impacts from HABs
Project Period: 2016-2019

"This centers on Tribal goals and values." – Colorado River Indian Tribes Project Administrator Joe Simms

Harmful algal blooms—the overgrowth of aquatic algae is a major problem across the nation. Blooms occur when excess nutrients (nitrogen and phosphorus), combine with sunlight and warm water temperatures. HABs can cause severe, negative impacts on aquatic ecosystems and human health. For many tribes, water bodies serve a cultural, recreational, and economic purpose.

To explore ways to eliminate or reduce the cumulative negative impacts of harmful algal blooms, EPA ORD, and Region 9 (Southwest) scientists worked with the Chemehuevi and Colorado River Indian Tribes to evaluate the effectiveness of man-made floating vegetated islands to remove nutrients from the water in Lake Havasu and the Lower Colorado River. Floating islands function by allowing plant roots to grow down into the water and absorb nutrients and minerals. Objective of this study is to determine if the plant populations native to the Lower Colorado River basin could be used on floating islands to absorb excess nutrients and reduce the occurrence of harmful algal blooms.

To construct the floating islands, EPA relied on relevant indigenous knowledge shared by the Colorado River Indian Tribes (CRIT) and Chemehuevi Indian Tribe (CIT) about essential plants used for food, cultural practices, and medicinal purposes within the Lower Colorado River basin. Environment staff from both tribes identified and collected culturally relevant plants—needle-spiked rush, gilia, tules and Parry's beargrass—and incorporated them into the design and construction of two 5'x10' floating vegetated islands. The native species are known to absorb nutrients such as phosphorous and nitrogen and are adapted to the local ecosystem.

The study, published in 2020, demonstrated rhizomic phytoremediation is very effective at absorbing nutrients and minerals in the dissolved fraction. The coverage area of the floating islands determines the overall effectiveness in reducing HABs. Using TEK establishes the potential ecosystem physical functional processes (i.e., vegetation, hydrology, soils and landform) of native plants. This study provided tribal decision makers with improved scientific information and tools to assess, predict and manage the risk of nutrients, HABs, associated toxicity events, and the resultant ecological, economic and health impacts.

Partners: San Francisco Estuary Institute (SFEI)
Challenge: Reduced ecosystem resilience and stability of San Francisco Bay from nutrient pollution
Resource: Statistical evaluation of 40 years of monitoring data in the San Francisco Delta region
Project Period: 2015 – 2018

"EPA ORD provided critical expertise in developing a scientifically-defensible approach to estimating chlorophyll-a concentrations in San Francisco Bay that would be protective of designated uses. This work is forming a foundation of science that will be ultimately used to develop nutrient management strategies for San Francisco Bay, which is one of the most nutrient-enriched estuaries in the United States." – Southern California Coastal Water Research Project Authority, Biogeochemistry Department Head Martha Sutula, PhD

San Francisco Bay on the Pacific Coast of the U.S. is one of the most prominent—and closely monitored—estuaries in the western hemisphere. A robust database compiled over the past four decades has revealed that the Bay has consistently high nutrient concentrations yet has rarely experienced eutrophication. Recent changes in land use and weather, however, could lead to changes from the historic norm.

Local management agencies have prioritized the analysis of the monitoring data collected over the years from the Delta region surrounding San Francisco Bay, a complex mosaic of inflows that receive, process and export nutrients from the watershed to the lower Bay, as a preliminary approach to understanding large-scale properties of the Bay.

EPA researchers helped to conduct the first comprehensive evaluation of the long-term monitoring dataset in the Delta. In collaboration with SFEI researchers, they applied statistical models for trend analysis to better understand regional water quality dynamics. The Weighted Regressions on Time, Discharge and Season (WRTDS) model was used to provide the descriptive potential of long-term data by describing variation in flow- normalized concentrations, frequency of occurrence of extreme events, and nutrient response to historical changes. Results will provide scientific support for nutrient criteria development, Total Maximum Daily Load implementations, and routine condition assessments. Information provided by these models can also be used to generate and test hypotheses of how responses to anthropogenic nutrient interacts with other environmental changes to cause eutrophication.

Learn more about ORD's regional monitoring efforts in the San Francisco Bay Delta.

Partners: Florida Department of Environmental Protection (DEP), Escambia County
Challenge: Nitrogen pollution in urban environments
Resource: Isotopes as tracers to identify sources of nitrogen pollution
Project Period: 2017

"Our partnership with EPA ORD offers us a wonderful opportunity to gain a better understanding of nutrient loads and likely sources within the Bayou Chico and Pensacola Bay watersheds. Funding for environmental restoration is always limited. Having this understanding allows Escambia County and our partners to prioritize projects that have the greatest potential to have a positive impact on our ability to attain our surface water quality goals. We hope to use this research in the future as the basis for better resource management decisions." – Escambia County Water Quality and Land Management Division, Manager Brent Wipf

Bayou Chico is part of the Pensacola Bay System in northwest Florida and the subject of a basin management action plan by the Florida DEP to improve water quality through reductions in nitrogen loadings. Moreover, local governments are investing heavily to restore Bayou Chico and spur economic development in the surrounding area. Two creeks in the watershed provide an ideal urban setting to compare nitrogen loadings between contrasting land use and land coverages. Jackson Creek traverses residential and business developments and is listed as impaired for elevated fecal coliforms and nitrogen levels. Jones Creek originates in a reclaimed nature preserve/greenway and rarely exceeds water quality standards for fecal coliforms and nitrogen.

EPA ORD scientists in collaboration with Region 4 (Southeast) and partners collected water and sediment samples in the creeks and watershed to compare and contrast potential sources, fate and transport of nitrogen in the two creeks. Sampling locations were located along the creeks, the bayou, adjoining lakes and wells for groundwater sampling. Samples were collected on a quarterly basis for base flow measurements and more frequently around rainfall events. Samples were then analyzed for a suite of water quality chemical parameters including nitrite, nitrate and chemical tracers of wastewater discharge. Elemental isotope ($\delta^{15}N$ and $\delta^{15}O$) data was analyzed using mixing models in conjunction with water quality data to provide estimates of N loading and turnover in the two creeks and their contribution to the bayou. This project provided the technical basis for the County and Florida DEP to better understand nutrient loads and sources in the watershed and inform decision making for the basin wide management action plan.

Partners: Barnstable Clean Water Coalition (BCWC); Massachusetts Alternative Septic System Test Center; the Town of Barnstable, Massachusetts; and the Massachusetts Department of Environmental Protection (MassDEP)
Challenge: Evaluating non-traditional approaches for reducing excess nutrients entering Cape Cod's coastal waters
Resource: Nutrients Solutions-Driven Research Pilot – neighborhood-scale demonstration of innovative/alternative septic systems in Cape Cod, in collaboration with U.S. Geological Survey (USGS) and The Nature Conservancy
Project Period: 2018 – 2021

"We've all heard the saying, 'If you want to go fast, go alone. If you want to go far, go together.' At the core of this proverb is the idea of partnership. Stellar results in business and in life usually have partnerships at their foundation, which has proven to be the case for BCWC's work in the Three Bays watershed. We were introduced to EPA ORD about four years ago at a fortuitous moment. EPA ORD was launching a program they call 'translational science,' where they work on a significant environmental challenge and look to partner with stakeholders to develop real-world solutions. For BCWC this has meant that our team has the opportunity to spend hundreds of hours working with the experts at EPA ORD to understand the nutrient pollution problem. We are working together on multiple approaches to reduce nutrient overload—one of the most significant problems for our Cape Cod waterways." – Barnstable Clean Water Coalition Executive Director Zee Crocker

EPA is collaborating with partners and stakeholders in the Cape Cod region to explore ways of reducing the amount of nutrients, specifically nitrogen, entering the Cape's estuaries and freshwater ponds to protect coastal waters. Excess nutrients from human activity are an increasingly serious threat to estuaries, wetlands, and freshwater ponds nationwide, as they contribute to algae blooms, low dissolved oxygen, degradation of seagrass, impaired freshwater, and estuarine ecosystems and, in extreme cases, fish kills.

Enhanced innovative alternative (IA) septic system designs have shown promise for removing much of the nitrogen in wastewater before it enters surrounding groundwater, estuaries, and ponds, but only a limited number have been field-tested. More installations and testing are needed to evaluate performance of the latest enhanced IA septic systems before they are considered for broader use. EPA, in collaboration with USGS, is partnering with BCWC, the Massachusetts Alternative Septic System Test Center, MassDEP, and the Town of Barnstable to implement a neighborhood-scale demonstration of enhanced IA septic systems, which are designed to prevent excess nutrients, such as nitrogen, from entering estuaries and freshwater ponds in the Cape Cod region. Results from this project will provide information needed on the effectiveness of alternative technologies for removing nitrogen from Cape Cod's waters and to understand which solutions work best for the region.

End goals of the demonstration project include quantifying nitrogen reduction and cost-effectiveness of the enhanced IA systems, evaluating how clustering these systems influences groundwater nitrogen, and communicating lessons learned to local, state, regional and federal partners in watersheds similarly compromised by legacy septic systems.

More information is available on the Innovative/Alternative Septic Systems webpage.

Partner: Clermont and Brown County (OH) Soil & Water Conservation Districts, Clermont County Office of Environmental Quality, Clermont County Water Division, Ohio EPA, Ohio Department of Agriculture/National Resources Conservation Service, Ohio Department of Natural Resources
Challenge: Managing excessive nutrient runoff into East Fork Lake (Lake Harsha), which is causing harmful algal blooms
Resource: East Fork Watershed Cooperative—a collaboration between local, state and federal entities including the U.S. Army Corp of Engineers (USACE), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service—and The Nature Conservancy
Project Period: 2010 – Present

"This partnership has made a huge difference in what we've been able to do at the local level. The research and expertise involved in the Cooperative has made things possible that we would never have been able to do on our own." – Clermont County Soil and Water District Administrator John McManus

Excessive nutrient runoff in East Fork Lake in southwestern Ohio causes harmful algal blooms (HABs). These HABs in turn can produce cyanotoxins, which are harmful to human health and can compromise drinking water safety. EPA ORD along with several federal, state and local agencies collaborated to form the East Fork Watershed Cooperative to address this issue.

This multiagency cooperative, led by EPA ORD staff, leverages resources to help demonstrate how to better protect water quality in the watershed. EPA provides technical support and guidance, runs watershed simulation models, provides expert review, assists USACE in monitoring water quality, participates in statewide HAB modeling efforts with USGS, and supports the state of Ohio on nutrient Total Maximum Daily Load (TMDL) implementation in the East Fork.

The short-term goal of the cooperative is to provide early warning and efficient treatment plans for the toxic algae problem in Lake Harsha. Their long-term goal is to eliminate the algae problem by reducing runoff from nonpoint sources.

More information on the East Fork Watershed Cooperative (EFWCoop) webpage.

Partners: Oregon Department of Environmental Quality (DEQ); Oregon Department of Agriculture
Challenge: Improve surface and groundwater nitrate contamination from agriculture
Resource: Collaborating with farmers to assess the effectiveness of fertilizer best management practices
Project Period: 2017 – 2022

"EPA ORD scientists have made significant contributions to the monitoring program in the southern Willamette Valley Groundwater Management Area. Their technical expertise has enhanced analyses of complex hydrological systems, as well as informed Oregon DEQ synthesis of multi-scale factors impacting nitrate concentrations in the southern Willamette Valley." – Oregon DEQ, Joni Hammond (former Acting Director)

Groundwater nitrate contamination affects thousands of households in the Southern Willamette Valley Groundwater Management Area (GWMA) in Oregon. To reduce non-point source loading of nitrogen to groundwater and surface water, successful approaches are needed within affected communities to integrate science, outreach and management efforts. A partnership was formed that brings together commercial farmers, Oregon Department of Agriculture, soil and water conservation districts and EPA to assess the current state of groundwater in the Valley, and to evaluate best practices in fertilizer management.

In this collaborative project, scientists measured nitrate leaching from 14 fields in the Valley. They shared the data with farmers and discussed best practices for fertilizer application that would reduce the leaching. Scientists documented the effectiveness of these practices on their fields and now are seeing positive results for less nitrate leaching in some fields. This work was published in Nutrient Cycling in Agroecosystems.

In addition, EPA ORD scientists have provided stable isotopic analyses to identify the causes of high temporal nutrient variability within local wells. These efforts have helped illuminate complex groundwater-surface water interactions and greatly improved Oregon DEQ's monitoring program for the groundwater management area. This works has been published in ORD efforts helped to reduce potential new inputs of nitrate into the groundwater system and understand the complex dynamics of groundwater in general.

EPA ORD scientists also worked with Oregon Department of Environmental Quality and Oregon State University Extension to produce a story map about the GWMA that allows the community to learn about well water nitrate sources, issues and progress in the GWMA.

Partner: Washington State Department of Fish and Wildlife (DFW)
Challenge: Managing nutrients in riparian ecosystems for fish and wildlife benefits
Resource: Science synthesis of nutrient processes in riparian ecosystems
Project Period: 2018 – 2019

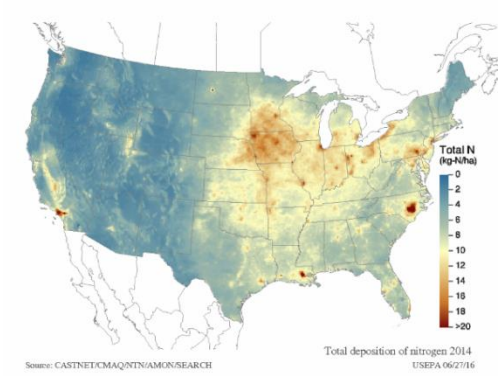
"EPA's willingness to co-author the nutrient chapter of the Washington DFW's riparian science synthesis document was critical to providing the best science to biologists, managers and policy makers throughout Washington. We viewed EPA as an essential partner that provided a very high level of expertise that Washington DFW simply did not have." – Washington State DFW, Chief Scientist Timothy Quinn, PhD

Riparian ecosystems and their streams are critically important locations for sustaining a healthy balance of nutrients—primarily carbon (C), nitrogen (N), and phosphorus (P)—across watersheds and far downstream. Vegetated riparian areas can be efficient natural filters by storing, removing, and "fixing" potentially harmful excess nutrients that flow into aquatic ecosystems from uplands dominated by human activities, such as agriculture and urbanization.

To assist Washington State DFW, EPA ORD scientists provided state-of-the-science information on nutrients and riparian ecosystems as a chapter in a guidance manual designed for states, tribes and commercial interests responsible for managing riparian zones. The chapter provides a basic understanding of nutrient (C, N and P) cycling in riparian zones, including stream channels and Pacific Northwest groundwater. In highlighting the well-studied effects of various land uses, this chapter provides state officials the key factors they need to consider for maintaining conditions needed for optimal nutrient transport, such as hydrologic connection, vegetation type, soil condition and salmon use of streams.

Access Washington State DFW guidance manuals for managing riparian zones.

Partners: Delaware Department of Agriculture, DC Department of Energy & Environment, Maryland Department of the Environment, Virginia Department of Environmental Quality, West Virginia Department of Environmental Protection
Challenge: Estimating the impact of atmospheric deposition on nutrient loading in Chesapeake Bay
Resource: Improved models for calculating historic and predicting future atmospheric deposition of nitrogen
Project Period: 2015 – Present



"Science-based decision-making is at the core of the Chesapeake Bay Program Partnership and ORD's work to update the CMAQ airshed model provided the partnership with a better understanding of past progress and well as future opportunities for reducing atmospheric sources of pollution." – Maryland Department of the Environment, Water and Science Administration Director Lee Currey

The Chesapeake Bay watershed includes parts of six states and the District of Columbia and is home to over 18 million people. It provides over $100 billion annually in economic benefits. However, the growth in industry, population, and agriculture in the watershed has degraded water quality, with much of the decline attributed to excessive nutrient loading.

Consequently, in 2010, a Total Maximum Daily Load (TMDL) was established to reduce nutrient loading to the Chesapeake Bay watershed. Atmospheric deposition is among the largest pathways of nitrogen loading to the watershed, and the individual and combined impacts of climate and emissions changes on nitrogen loading from NH_x and NO_x to the watershed had not been well assessed.

Working in collaboration with the EPA Region 3 (Mid-Atlantic) Chesapeake Bay Program, EPA ORD scientists tailored the Community Multiscale Air Quality (CMAQ) modeling system so that it could be used to estimate atmospheric nitrogen deposition for historical (2002 – 2012), near-term (2017, 2023, 2028), and future (2023, 2028, 2045 – 2054) scenarios. The work was conducted to assist partner states and watershed managers.

The work revealed that average meteorological and atmospheric nitrogen deposition model estimates for the historical period matched the observations well and were comparable to retrospective simulations that use observational data assimilation. The future meteorological simulations estimated that the Chesapeake Bay watershed would be warmer, more humid and receive more precipitation by 2050. The future projections also displayed more variability in precipitation compared to historical and current scenarios. Future CMAQ simulations estimated a 21% reduction in atmospheric nitrogen deposition to the watershed, while the future simulation with historical emission rates indicated only a 4% increase in nitrogen deposition due to changes in meteorology (particularly the increase in precipitation). As a result, the nitrogen deposition estimates generated were used in the Phase 6 version of the Chesapeake Bay Model for the 2017 Chesapeake Bay TMDL Midpoint Assessment and have been widely distributed among the federal, state, local and academic Chesapeake Bay Program research partners as they consider options for reducing nutrient loading.

Read the peer-reviewed publication Projections of Atmospheric Nitrogen Deposition to the Chesapeake Bay Watershed in the Journal of Geophysical Research – Biogeosciences.

WATER – QUALITY

Partner: Ohio Environmental Protection Agency (Ohio EPA) and the Great Lakes National Program Office (GLNPO)
Challenge: Remediation and restoration of Great Lakes Areas of Concern (AOCs)
Resource: Technical and sampling support in partnership with the Ohio EPA, GLNPO, U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration
Project Period: 2019 – Present

"ORD has provided valuable technical support for several Maumee AOC projects. ORD provided technical, sampling and report writing support in late 2021 for the purpose of collecting and evaluating multiple lines of evidence – chemical, physical, and biological – to define contaminated sediment management areas." – Ohio EPA Environmental Specialist Lynn Ackerson

Ohio EPA is implementing several projects in the Maumee AOC in northwest Ohio. The projects are funded by the Great Lakes Restoration Initiative (GLRI), which is designed to protect and restore the chemical, physical and biological integrity of the Great Lakes Basin ecosystem. Completion of these projects and demonstration of chemical and biological improvements will contribute to the removal of Beneficial Use Impairments in this AOC. Since 2019, a technical work group focused on characterizing sediments in Swan Creek and the Lower Maumee River to support these projects and collaborate on developing a data gap sampling plan, field sampling, and report writing to support identification and remediation of contaminated sediments. In addition, the ORD-led team of federal partners have provided support for Ottawa River remedy effectiveness studies and Otter Creek remedy and restoration effectiveness studies.

EPA ORD scientists have assisted with various studies, such as the Swan Creek and Maumee River final sediment characterization reports and feasibility studies and the Otter Creek remedy effectiveness studies including non-federal sponsor led mussel mitigation. Overall, EPA ORD's technical and sampling support from site and baseline characterization, remedy and restoration effectiveness studies, and report writing is fundamental to supporting the Maumee AOC in addressing Beneficial Use Impairments.

Partner: City of Ada (OK); Chickasaw Nation
Challenge: Enhancing limited local groundwater supplies
Resource: Investigating the impacts of Enhanced Aquifer Recharge (EAR) on groundwater quality/ quantity
Project Period: 2020 – Present

"Enhanced aquifer recharge represents a process, once scientifically proven, that will provide a practical solution to rising demand for additional water resources, and potentially a definitive resource management approach to aquifer sustainability." – Chickasaw Nation's Natural Resources Office Director Kris Patton

In south central Oklahoma, where water and rainfall can be scarce, the Arbuckle-Simpson Aquifer is a critical water source. The aquifer, a store of groundwater within the underground rock layers, is the primary source of drinking water for tens of thousands of people, including the Chickasaw Nation. Additionally, the aquifer provides water for agriculture, mining and other industries. It is also the source of many springs, lakes and rivers—providing important recreational and tourism resources to the area. The aquifer is designated as a "sole-source aquifer," a recognition that there are no reasonably available alternative drinking water sources. The aquifer relies solely on precipitation to recharge the groundwater supply, as no other water source enters the aquifer.

The challenge of studying groundwater, however, is that it is not readily observable, like a stream or lake. Scientists from EPA ORD have been working with federal, tribal, state and academic partners, including the City of Ada, Oklahoma and the Chickasaw Nation, whose headquarters are in Ada, to understand the impacts of human activities (like pumping water from the aquifer) on the aquifer's water quality and quantity. EPA and its partners are also conducting research to understand the geological controls on groundwater flow, its underground "plumbing system." Scientists have developed conceptual models of how rainfall percolates through the ground to recharge the aquifer. To check these models, they have installed monitoring wells, water autosamplers, and weirs at a site within the aquifer to measure changes in water levels and water quality. Other EPA research includes electrical resistivity imaging to map the subsurface to "see" the apparent water movement through the subsurface, and enhanced aquifer recharge (EAR) approaches. EAR uses small dams and weirs to capture water from significant rainfall events, allowing it to infiltrate into the ground, rather than run off the surface.

The studies EPA scientists are conducting and the concepts and the techniques they are using at the Arbuckle-Simpson Aquifer can be applied in other aquifers facing similar resource management issues. This research will inform the City of Ada, EPA regions, states and other partners of the risks and potential impacts to groundwater quality from the use of EAR in rural settings to recharge aquifers. This research will allow water managers to establish initial best management practices and policies on the use and maintenance of EAR systems; and identify the types of characterization and monitoring necessary for the implementation and long-term monitoring and maintenance at EAR sites.

Partner: DC Department of Energy & Environment (DOEE)
Challenge: Application of advanced monitoring technologies to characterize fecal pollution sources in regulated MS4 dischargers in Washington, DC
Resource: Field research, technical support, and laboratory training
Project Period: 2019 – Present

"For many years, DOEE has been restoring DC's streams and major waterways with the goal of achieving fishable and swimmable status. A major hurdle has been high levels of microbial contamination that impair waterways via raw sewage overflows, leaky pipes, illicit discharges, and wildlife/domestic pet excrements. The first step towards controlling and mitigating microbial contamination is to identify the sources. Through a valuable partnership with EPA, DOEE has conducted an extensive field study to track microbial pollution in headwater streams of the Anacostia River. Once field collected samples are analyzed by EPA ORD, results will assist DOEE in developing focused control and mitigation strategies. This will help us get one step closer towards achieving fishable and swimmable status in DC's waterways."
– DC DOEE Water Quality Division, Environmental Scientist Amir Sharifi, PhD

More than 80% of the United States population resides in areas with municipal separate storm sewer systems (MS4) resulting in over 7,500 communities with the responsibility to develop, implement and mitigate stormwater management programs. Urban stormwater can contain disease causing pathogens and other pollutants and is a leading cause of surface water impairment in the U.S. Genetic technologies are now available that can help characterize key source(s) of fecal pollution in stormwater discharges helping to provide communities with more cost-effective, focused remediation, and prevention strategies.

EPA ORD, in collaboration with EPA Region 3 (Mid-Atlantic) and the Office of Water, has partnered with the DC DOEE to conduct a field research study to evaluate the use of genetic fecal source identification technologies for MS4 outfall pollutant characterization in the DC area. In addition, EPA ORD is providing technical support and training to DOEE staff to promote the local use of these methods for future stormwater management efforts.

EPA ORD technical support and training will help educate local stormwater managers and facilitate the use of advanced monitoring technologies in the District. Field study results will provide DOEE with important information to improve stormwater management. In addition, findings will serve as a foundation for the development of a strategic MS4 monitoring approach that can be used by DOEE and other stakeholders across the U.S. to address future stormwater management challenges.

The study was summarized in a presentation titled Fecal Source Characterization of Regulated MS4 Discharges in Washington, D.C.

Partners: Chattahoochee River Keeper, University of Georgia-River Basin Center, and Athens Clarke County Stormwater Department (GA)
Challenge: Tracking down the source of high levels of fecal indicator bacteria in an urban watershed
Resource: Geospatial tools and innovative DNA analysis in combination with citizen science to advance stakeholder awareness and engagement
Project Period: 2015 – 2018

"The data generated through informative community science initiatives such as the ORD project in Proctor Creek assist Chattahoochee Riverkeeper and community efforts to better understand and address water quality conditions and threats, with the ultimate goal of targeting problem areas and addressing issues to create healthier neighborhood waterways and improve the lives of those impacted." – Chattahoochee Riverkeeper, Neighborhood Water Watch Director, Mike Meyer

This study took place within the Proctor Creek and Oconee River watersheds in Georgia, which are highly impacted by activities such as urban development, aging sanitary sewer systems, and failing infrastructure. At the time of the study, the sampled streams were on EPA's 303 (d) list of impaired waters for exceeding fecal coliform standards. Because these streams are designated for recreational activities such as fishing, and the community regularly comes in direct contact with the water, a possible public health hazard exists.

EPA researchers took biweekly grab samples from various sites throughout the watersheds and analyzed them for potential pathogens and genetic markers of animals and human-associated bacteria, including birds, canine and deer, the pathogenic bacteria *Salmonella*, and the virulence gene (*Stx-2*), frequently found in *E. coli* O157. In addition, they also measured water chemistry parameters. Results show that Proctor Creek and the Oconee River are highly impacted by human fecal contamination, and it is persistent and widespread throughout. Sources of human contamination are particularly high in the watershed headwaters. Dog fecal contamination was present only intermittently and, when present, it was found in very low concentrations. *Salmonella* was also widespread throughout the Proctor Creek watershed; however, data suggest that it is not originating from humans.

Information from this study will support county and city officials as well as non-governmental organizations, such as Chattahoochee River Keeper and the University of Georgia-River Basin Center, in addressing local stream impairment and allow them to work with federal agencies to implement more efficient Best Management Practices (BMP) within a watershed.

Access the Proctor Creek Water Monitoring Reports.

Partner: Michigan Department of Environment, Great Lakes, and Energy (EGLE)
Challenge: Timely public notification of microbiological water quality at inland and Great Lakes recreational beaches
Resource: Validate and implement rapid water monitoring technology for *E. coli* fecal indicator bacteria
Project Period: 2016 – Present

"Michigan is excited to be the first state to use qPCR methods for testing beach water across the entire state and to be a pioneer in using this method for a new water quality indicator at beaches. Our citizens and visitors will know before they swim that it is safe to do so, and beaches will open sooner after an advisory. We are pleased that the US EPA is a partner in helping us achieve this goal." – Michigan EGLE, Water Resources Division Director Teresa Seidel

Michigan uses *E. coli* to set water quality standards for recreational use, for both total and partial body contact. Current culture-based methods for detecting *E. coli* in the water are not timely, typically providing results after people may have been exposed to contaminated water or long after "safe" beaches were closed awaiting results. Michigan initiated a statewide effort to change this, instead using a rapid quantitative polymerase chain reaction (qPCR) method to monitor inland and coastal freshwater beaches. In 2012 EPA provided water quality criteria for both culture and qPCR methods for another fecal indicator bacteria group, enterococci, but not for *E. coli*.

EPA has been collaborating with Michigan EGLE and Michigan State University to conduct studies to validate EPA draft Method C, a rapid qPCR method developed by EPA ORD for quantitative detection of the state-approved water quality indicator organism, *E. coli*. ORD has also provided training to labs in the use of this new method.

Another part of this collaborative effort between EPA and Michigan EGLE is to establish *E. coli* values as measured with draft Method C that are equivalent to current culture-based beach notification values at over 100 inland and Great Lakes beaches throughout the state. Data collected both by the ORD and local Michigan laboratories have been used in making this determination. A collaborative effort between Michigan EGLE, EPA ORD and the Office of Water led to the establishment of Michigan-wide beach notification value using EPA E. coli qPCR method (draft method C) that was implemented for the 2019 and 2020 beach seasons. These efforts led to the use of a more rapid, validated method being put in the hands of university, water quality, and public health laboratories throughout the state.

Read the final report titled *Evaluation of multiple laboratory performance and variability in analysis of recreational freshwaters by a rapid Escherichia coli qPCR method (Draft Method C).*

Partner: Minnesota Pollution Control Agency (MPCA)
Challenge: Development of an updated sulfate standard
Resource: Technical support to the state by expert consultation and peer review
Project Dates: 2011 – 2018

"MPCA values the scientific expertise and partnership of EPA ORD, as we have worked to understand the complex physical, chemical and biological relationships that impact wild rice growth in Minnesota's lakes, stream and wetlands. By cooperating with the ORD's Mid-Continent Ecology Division and other scientific experts, the MPCA has developed ground- breaking improvements in our understanding of these relationships." – MPCA, John Linc Stine (former Commissioner)

EPA ORD scientists supported an ongoing effort in Minnesota to better understand and address the effects of sulfate and other substances on wild rice, which is an important component of many of Minnesota's lake and stream ecosystems, and a highly valuable economic and cultural resource for many state residents. ORD researchers consulted with lead scientists from MPCA on both the original study protocol and the technical aspects of the study, and then on the analysis and interpretation of the resulting data. ORD also consulted with EPA Region 5 (Midwest) on aspects of sulfate water quality standards.

In May 2018, MPCA withdrew its proposal to amend the sulfate water quality standard. EPA ORD's technical support improved understanding of how to protect Minnesota's wild rice that will be valuable for decision makers for any future determination.

Partners: Mississippi Department of Environmental Quality (DEQ), Turkey Creek Community Steering Committee
Challenge: Multiple sources of fecal contamination
Resource: Fecal bacterial and viral indicators for identification of pollution sources
Project Period: 2016 – 2019

"Along with these efforts in Turkey Creek, Mississippi DEQ feels very fortunate to have benefited from our ongoing partnership with EPA's Gulf of Mexico Program and ORD's Gulf Ecology Division. As with all successful partnerships, we attribute these successes to the dedicated staff at our respective agencies along with the community leaders and their commitment to collaboration and communication throughout the project. We look forward to future opportunities for successful collaboration." – Mississippi DEQ, Field Services Division Chief Doug Upton

Turkey Creek in Gulfport, Mississippi, is listed as impaired due to fecal contamination under the Clean Water Act. Pollution control measures are only effective if the sources are identified. In 2007, Mississippi DEQ included three monitoring locations on Turkey Creek as part of an Ambient Recreational Monitoring Network. As this contamination issue had persisted for some time, EPA ORD began assisting in 2016 by collecting samples at the monitoring stations and employing novel viral and community microbiology techniques to compare with standard bacterial techniques.

These locations were sampled and evaluated for *E. coli* during both the contact (May – October) and non-contact (November – April) seasons. The local community's plans included the need to identify and mitigate all pollution sources for both Turkey Creek and Bayou Bernard and establish regular monitoring to ensure water quality.

EPA ORD scientists and partners collaborated on research to identify the sources of fecal pollution in Turkey Creek, leveraging the current successful community citizens' science bacterial monitoring program established by the EPA Gulf of Mexico Program. Collaborators from the Gulf of Mexico Program were in regular communication with Mississippi DEQ. Through a monthly sampling scheme, fecal sources were identified through characterization of viral genotypes and microbial communities in the water column and sediment. The project also evaluated land use, stream hydrology and urban sewage treatment in the landscape for the identification of point and non-point pollution sources. Data from this project will be shared to better inform decisions made by Mississippi DEQ and the local Turkey Creek Steering Committee to control fecal contamination in Turkey Creek.

The project report was completed in October 2019. The EPA report was peer-reviewed and published in 2020.

Partners: Mississippi Department of Marine Resources (DMR), Grand Bay National Estuarine Research Reserve (GBNERR)
Challenge: Better understanding acute and chronic effects of industrial spills on ecosystem health in a coastal reserve
Resource: Analysis of ten years of monitoring data to describe water quality changes from industrial spills, in collaboration with the National Oceanic and Atmospheric Administration (NOAA)
Project Period: 2004 – 2018

"When there's an industrial spill, we want to be able to respond appropriately. Analyzing effects of prior spills on things we measure in our long-term water quality and nutrient monitoring program helps us plan for such situations by understanding the past. ORD staff has been incredibly helpful in analyzing the data – bringing both statistical and software expertise to the project. Through the process, they've helped us get a better idea of how to analyze and interpret our long-term monitoring data. This is also helping with other data analyses and will be used by other state agencies." – Mississippi DMR, GBNERR Monitoring Coordinator Kimberly Cressman

Grand Bay is part of the National Estuarine Research Reserve System (GBNERR) established as a federal partnership with the Mississippi DMR to address long-term research, monitoring, education and stewardship goals. The reserve includes 18,400 acres of protected areas that cover several coastal habitats including pine savannas, salt marshes, seagrass meadows and oyster reefs. Researchers at GBNERR work collaboratively to advance science-based management and appreciation of the reserve's unique resources. Although GBNERR is relatively pristine, industrial activities have negatively affected the health of the bay. One of the largest fertilizer production facilities in Mississippi is located in the nearby city of Pascagoula. Extreme weather caused two spill events in 2004 and 2011. Highly acidic and phosphorus-rich wastewater entered GBNERR, causing dramatic changes in water quality and observed fish kills. Understanding the immediate and potentially long-term effects of these events is a priority for effective management of GBNERR.

Understanding long-term changes in water quality is critical to describing historical impacts and developing expectations of future changes of the ecosystem health of GBNERR. Research staff at GBNERR have been collecting routine monitoring data at several locations since 2004. After attending an EPA ORD workshop on time-series analysis, GBNERR staff initiated a collaborative effort to describe the response of nutrient parameters in GBNERR in relation to acute and chronic effects of each spill event, as well as spatial changes in these parameters among the monitoring sites. Previous studies have been limited in the amount and quality of data used to describe such spill events. Results from this analysis provided critical information on estuarine response to industrial impacts—most estuaries are nitrogen-limited, so the effects of phosphorus inputs are not well understood. This collaborative work not only addressed a critical research gap, but also described potential changes in GBNERR water quality that can guide Mississippi DMR in more effective management of this unique and valued ecosystem. EPA ORD scientists continue to provide technical support for model development and application.

Read the final report titled *Water quality trends following anomalous phosphorus inputs to Grand Bay, Mississippi, USA.*

Partner: New Mexico Environmental Department (NMED)
Challenge: Develop water quality assessment methods for highly altered systems, such as the middle Rio Grande
Resource: Integrated and organized existing physical, chemical, and biological data to develop and calibrate models for both fish and benthic macroinvertebrate communities based on the Biological Condition Gradient (BCG) approach and technical expertise
Project Period: 2018 – 2020

"The Biological Condition Gradient models developed with EPA and an interdisciplinary team of experts are a leap forward for water quality protection of the middle Rio Grande. We look forward to continued collaboration with EPA in developing new methods to protect New Mexico's water resources." – New Mexico Environment Department Water Protection Division Director Rebecca Roose

A lack of defined numerical thresholds limits the ability of the state of New Mexico to sustain, restore and protect non-wadeable rivers in the state, a major source of water for most of the state's population. In addition, because these rivers have been greatly altered from their original conditions, "minimally disturbed" reference waters do not exist for determining threshold assessments.

To address these challenges, EPA researchers, in collaboration with EPA Region 6 (South Central), NMED, Tetra Tech, and a panel of fish and macroinvertebrate experts from a number of organizations and universities, developed a suite of Biological Condition Gradient (BCG) models for fish and benthic macroinvertebrate communities of the middle Rio Grande, which is habitat for the threatened and endangered Rio Grande silvery minnow. The BCG provided the state with a tool to evaluate biological expectations over a range of stressor conditions within the middle Rio Grande.

EPA ORD, in collaboration with EPA Region 6, Tetra Tech and NMED, using data from EPA's National Aquatic Resource Surveys, also found the BCG models to be potentially applicable to other sandy-bottomed rivers in the southwestern United States.

NMED intends to use the BCG models to develop quantitative thresholds of biological condition to evaluate the level of impairment from stressors such as excess nutrients and sediments in the middle section of the Rio Grande. Similar thresholds may be developed for other non-wadeable, sandy-bottomed rivers within the state.

Partner: Oregon Department of Agriculture (ODA)
Challenge: Managing Oregon's commercial shellfish harvests to reduce public health risk
Resource: Improved methods to forecast environmental conditions that lead to shellfish harvesting closures
Project Period: 2004 – 2018

"Tillamook Bay is one of the most productive and diverse commercial shellfish growing bays in Oregon. Environmental characteristics and human development in the watershed also make it one of the most complicated in terms of pollution impacts. The work EPA is doing on fecal indicator bacteria will provide valuable information on sources of water pollution at a level that has not been possible before. This information will be used to ensure safe food can continue to be produced from this bay and help maintain the livelihoods it supports."
– ODA Food Safety and Animal Health Program, Food Safety Inspector & Shellfish Specialist Alex Manderson

To protect human health, state agencies close estuarine waters to shellfish harvest during periods of elevated fecal bacteria and other factors. In Tillamook Bay, Oregon, elevated bacteria levels result in shellfish harvest closures approximately 100 days a year, affecting the State's largest concentration of commercial wild-caught shellfish and oyster aquaculture operations. The ODA has authority to restrict the harvesting and distribution of shellfish by commercial processors if there is potential risk for illness to consumers. The ODA bases harvest closure decisions on river flow and precipitation, which works well during wet seasons when runoff may carry fecal bacteria from urban or agricultural sources into shellfish growing areas. However, these environmental variables do not predict elevated fecal bacteria levels well during dry, summer months during peak shellfish harvesting season. Ultimately, season-specific criteria for determining high bacterial loads in the vicinity of shellfish beds would help ODA better ensure the safety of commercial shellfish for the benefit of consumers and the shellfish industry.

Researchers from EPA have collaborated with ODA shellfish managers to develop improved models to forecast environmental conditions indicative of unsafe levels of fecal bacteria within Tillamook Bay. The research involved statistical analysis of environmental drivers (such as rainfall, wind strength, temperature, river discharge, tide stage) that are associated with changes in the fecal bacteria concentrations at several locations within the estuary, using ODA's bacterial data and publicly available environmental data. The analysis revealed seasonal and locational differences of which environmental drivers had the greatest influence on bacterial levels.

Consequently, under a given set of environmental conditions, some parts of the estuary might not require harvest closure, whereas others would. High precipitation and river discharge lead to elevated bacteria levels during wet months (October to May), as expected. During dry seasons (June-September), the research revealed that elevated bacterial levels were associated with strong winds and tidal extremes, and the EPA-developed statistical models performed better than ones currently used by ODA. The models developed by EPA may be used to inform ODA's approach for shellfish harvest closures and improve the effectiveness of future bacterial monitoring efforts.

Read the final report titled *Statistical models of fecal coliform levels in Pacific Northwest estuaries for improved shellfish harvest area closure decision making*.

Partners: Washington State Department of Natural Resources, Washington State Department of Ecology, Nisqually Land Trust, Nisqually Tribe
Challenge: Improve watershed condition for salmon recovery, clean drinking water and other ecosystem services
Resource: EPA watershed restoration planning tools (VELMA, Penumbra) and technical support
Project Period: 2015 – Present

"Guided by sophisticated new modeling from EPA ORD's Western Ecology Division in Corvallis, combined with modeling used by the Nisqually Tribe for salmon recovery, the community forest's management team will selectively thin the property's timber stands to encourage old-growth forest characteristics and increase stream flow during the fall spawning season." – Nisqually Land Trust, Executive Director Joe Kane

Intensive forest management in the Pacific Northwest during the past century has emphasized clearcutting on short harvest intervals (40-50 years). This highly profitable practice has converted the region's vast pre- settlement old-growth forests to young forest landscapes. This has fundamentally changed the functioning forest watersheds and their capacity to sustainably provide essential ecosystem services (nature's benefits) for local and downstream communities. Provisioning of drinking water, flood protection, fish and wildlife habitat, and recreational and cultural opportunities have been significantly degraded in many places.

Indicative of these widespread changes, Puget Sound salmon populations have declined sharply from historic levels. For example, 22 of at least 37 Chinook populations are now extinct, and many other species are listed as endangered. Communities, tribes and state agencies (Departments of Natural Resources and Ecology) are now collaborating throughout the region to implement salmon recovery plans that aim to restore hydrological and ecological processes critical to salmon recovery, and more broadly, to the functioning of entire watersheds and the ecosystem services they provide. A prime example is the Nisqually Community Forest (NCF), a novel collaboration of communities in southern Puget Sound aimed at acquiring private forest industry lands from willing sellers. The NCF is a working forest owned and managed for the benefit of local communities.

EPA ORD has developed and transferred modeling tools to NCF to support their salmon-recovery planning in the Mashel River watershed, a once prime salmon producing sub-basin of the Nisqually River. NCF staff are currently using EPA's Visualizing Ecosystem Land Management Assessments (VELMA) watershed simulator to quantify long-term effects of alternative management and climate scenarios on key salmon habitat and water quality variables. A key NCF goal is to design sustainable management plans that emphasize forest thinning and robust riparian buffers, a strategy shown by VELMA simulations to restore greater summer stream flows favorable to salmon spawning. Other ongoing NCF projects using VELMA include prioritization of land acquisitions, community-based best management practices and long-term management strategies.

Access the presentation slides describing this collaborative project titled *How Visualizing Ecosystem Land Management Assessments (VELMA) modeling quantifies co-benefits and tradeoffs in Community Forest management*.

Partner: Washington State Conservation Commission
Challenge: Improving water quality impacted by fecal pollution in Washington
Resource: Collaborating on technical oversight committee concerning implementation of DNA-based microbial source tracking tools along with members from Washington State Conservation Committee, Washington Department of Agriculture, Washington State Department of Ecology, and Whatcom Conservation District
Project Period: 2017 – 2019

"The Washington State Conservation Commission has really appreciated and relied on ORD's help and scientific knowledge and expertise of microbial source tracking. EPA ORD gave our agency panel an informational presentation on what microbial source tracking actually is and how it can be used. The information helped our panel understand the scientific concepts around it, which in turn, helped the panel in selecting the best project." – Washington State Conservation Commission, Management Analyst Karla Heinitz

Every citizen, community, state, tribe and economy relies on clean, safe water. The number one biological contaminant in U.S. surface waters is fecal pollution leading to impairment of almost 10,000 water bodies across the country.

EPA, in collaboration with members from the Washington State Conservation Committee, Washington Department of Agriculture, Washington State Department of Ecology, and Whatcom Conservation District, were part of a technical oversight committee. This committee was organized by the Washington State Conservation Commission to support the implementation of DNA-based microbial source tracking tools across the state in 2017-2019.

The goal of the committee was to prepare a request for proposals (completed March 2018) and select a suitable project that would help educate, build laboratory capacity, and implement DNA-based microbial source tracking tools, some developed by EPA ORD, statewide (completed in August 2018). A demonstration project was then conducted over a five-month period to characterize fecal pollution sources after storm events in Vaughn Bay, WA. The project was completed in July 2019 resulting in quantitative fecal source information leading to recommended source control actions to reduce fecal pollution in Vaughn Bay, as well as a series of method protocols for cost-effective application in other Washington state watersheds.

WATER – SOURCE AND RECREATIONAL PROTECTION

Partner: Kansas Department of Health and Environment (KDHE)
Challenge: Efficient and defensible survey designs for stream monitoring
Resource: Probabilistic survey designs integrating national and state reporting requirements
Project Period: 2007 – 2018

"In my view, this collaboration with ORD is a very good example of the state-national partnership we have had with ORD. The Corvallis Lab provided the statistical expertise and analytical framework, and we provided our local knowledge and creativity and put our state level monitoring priorities on the table. The result is a survey design that is better for everyone involved." – KDHE Division of Environment former Director John Mitchell

Kansas Department of Health and Environment (KDHE) is charged with reporting on the stream condition for all streams in the Kansas Surface Water Register (KSWR), which was developed in 1994.

It is a challenge for both state- and national-scale assessments to develop a monitoring program that ensures representativeness when only a limited number of locations are available for sampling. If the state and national monitoring efforts can be integrated, it not only supports inter-calibration but is efficient and cost-effective. EPA ORD uses a probabilistic sampling design that ensures representativeness and allows the use of statistical tools to determine condition values and the reliability of those estimates (uncertainty). This strategy is the foundation of the National Aquatic Resource Surveys (NARS), which includes national-scale assessments of rivers and streams, lakes, coastal zones and wetlands. In working to refine the KSWR, KDHE was interested in whether the KSWR monitoring program could be integrated with the NARS National Rivers and Streams Assessment (NRSA).

In collaboration with EPA ORD, Kansas first conducted a study to determine if the KSWR included all the streams with flowing water required by NRSA. After determining that was the case, EPA ORD used the Kansas Register of streams as part of the NRSA 2018-19 survey design. By integrating state requirements for Kansas with NRSA requirements, Kansas reached a cost-effective solution for meeting their state assessment needs and simultaneously participating in the NRSA survey.

Partner: New Hampshire Department of Environmental Services (NHDES)
Challenge: Stream assessment integration and efficiency
Resource: Probabilistic survey designs integrating national and state reporting requirements
Project Period: 2018

"The partnership between EPA ORD and NHDES on the national stream assessments has created synergies that allow both organizations to meet their respective goals. Using each organization's strengths – NH DES' familiarity with streams in the state and EPA's skill with survey sampling design – the result is far greater than either could achieve alone." – NHDES Water Pollution Division Watershed Management Bureau, Biomonitoring Program Manager Andy Chapman

The NHDES Water Quality Assessment Program is responsible for reporting on the quality of the streams in New Hampshire under the Clean Water Act. It is impossible to sample every stream, so NHDES sought a means to subsample streams in such a way that was representative of all state streams. EPA researchers have developed a statistically robust protocol for doing just that. EPA ORD scientists have developed a probabilistic survey design that ensures that results from sampled locations are representative of the condition of all streams in the survey area. This strategy has been incorporated into the National Aquatic Resources Surveys (NARS), which includes national-scale assessments of rivers and streams, lakes, coastal zones and wetlands.

NHDES assembled a geographic data layer that identifies all streams within the state that must be assessed. They requested that EPA ORD integrate this stream data layer into the NARS National Rivers and Stream Assessment (NRSA). Using their stream network instead of the NRSA network enables the state to use the results of the state survey for the national dataset. Consequently, the state will conduct a state-level survey design for 2018-22 and integrate it with NRSA. This integration of the state and national survey designs is a cost- effective option for participating in NRSA while also meeting state assessment requirements.

In 2004, EPA partnered with states to provide national and regional level assessments for Clean Water Act reporting. EPA ORD has assisted 53 different states, tribes and territories since 2012 to develop sample survey designs and biological, chemical and physical habitat indicators. The survey designs provide statistical rigor for small sample sizes, which allow states to report on more of their waterbodies than previously possible.

Partner: City of Moab, Utah
Challenge: Understanding the impact of a wastewater treatment upgrade for the Colorado River
Resource: Monitoring contaminants and their associated biological effects before and after replacement of aging wastewater treatment plant, in collaboration with the U.S. Geological Survey (USGS), National Park Service (NPS), and Colorado State University
Project Period: 2018 – 2019

"This [work with EPA ORD] demonstrates that new technology can make a big difference in reducing wastewater contamination and preventing negative impacts downstream." – City of Moab, Utah City Manager Chuck Williams

The Moab wastewater treatment plant, originally built in the 1950s, services approximately 5,000 year-round residents, as well as a growing population of more than a million tourists that visit the city annually for outdoor recreation and nearby national parks (Arches and Canyonlands). To handle the increased capacity, the city completely replaced its wastewater treatment facility in 2018.

In 2018 and 2019, EPA ORD, in collaboration with EPA Region 8 (Mountains and Plains), USGS, NPS and Colorado State University, monitored nearby reaches of the Colorado River as part of a before-and-after study of the impact of the wastewater treatment plant replacement. Concentrations of common wastewater contaminants including pharmaceuticals, hormones and nutrients were measured bi-monthly. Additionally, biological parameters associated with reproduction, stress and metabolism were monitored using both laboratory and field-based methods.

After the new wastewater treatment facility was brought online in August 2018, there were significant reductions in both the number and concentrations of contaminants detected in the river. Likewise, biological responses associated with hormonal control of reproduction and stress response were significantly reduced. Results also indicated that both contaminant concentrations and biological responses associated with the wastewater discharge rapidly diminished downstream through dilution, degradation, and/or binding to sediment. Given the spatial patterns observed, longer-term monitoring can be focused on sites within 100 meters upstream and downstream of the discharge.

Overall, results provide initial evidence that investments in upgraded wastewater treatment infrastructure were beneficial for both reducing and limiting the potential impacts of wastewater associated contaminants in reaches of the Colorado River near Moab, UT.

Partners: Local and regional beach managers across states that border the Great Lakes, as well as other states
Challenge: Predicting water quality at beaches
Resource: Virtual Beach software
Project Period: 2007 – Present

"This reliable, predictive water quality model is key to protecting health and promoting recreational enjoyment of our beaches. The model provides same-day public notifications of beach conditions at a lower cost than traditional monitoring. Communities that use Virtual Beach can dedicate more of their resources to locating and correcting sources of contamination and improving local beaches. The (Wisconsin DNR's) partnership with EPA in the development of this practical scientific tool offers a great pay off." – Wisconsin DNR former Secretary Cathy Stepp

To protect public health, beach managers need to continually assess the level of potentially harmful microbes (primarily bacteria) in the water. However, traditional culture-based testing methods take a full 24 hours to get results – preventing same-day, proactive beach closures and leaving many recreational swimmers open to sickness or infection, or potentially close a beach needlessly and incur economic losses. EPA's Virtual Beach software offers a solution.

Virtual Beach facilitates efforts to support the local economy while protecting the health of residents. Virtual beach is used to assist in advisory issuances in the Great Lakes states and to forecast water conditions in numerous locations in Illinois, Indiana, Maryland, Michigan, Minnesota, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, and Wisconsin. In recent years, the software has been used for modeling water quality at water intake pipes (due to harmful algal bloom concerns) and shellfish harvesting areas (fecal coliform of typical concern) along the southern Atlantic coast.

An updated, web-based version of Virtual Beach is currently being developed. It will provide cutting-edge analytical tools, like ensemble modeling using a variety of machine-learning algorithms, as well as methods for handling non-detects and missing data, in order to maximize the predictive accuracy of water quality models while not over-fitting the training data which leads to much poorer predictions. This package will be a general analytical tool that can be used for a large variety of site-specific modeling questions, e.g., at recreational beach sites, shellfish harvesting areas, or public drinking water intake locations.

Partners: Depts. of Environmental Protection (KY, MA, ME, NJ, PA and WV); Depts. of Environmental Management (AL and RI); CT Dept. of Energy & Environmental Protection; DE Dept. of Natural Resources and Environmental Control; Depts. of Natural Resources (GA, MD and Red Lake Nation (tribal)); MA Dept. of Fish & Game; NH Dept. of Environmental Services; Depts. of Environmental Conservation (NY and VT); Depts. of Environmental Quality (NC and VA); SC Dept. of Health & Environmental Control; TN Dept. of Environment & Conservation; VA Dept. of Game and Inland Fisheries; Susquehanna River Basin Commission; TN Valley Authority
Challenge: Develop a baseline monitoring network to detect long-term trends
Resource: Technical support to states and tribes through workshops and stream monitoring network development, in collaboration with the U.S. Forest Service and the U.S. Geological Survey
Project Period: 2012 – Present

"As an interstate agency, the Susquehanna River Basin Commission (SRBC) certainly recognizes the value of the regional partnership EPA has assembled to address the need for collecting the data necessary for detecting changes to water quality and aquatic life communities over time, especially as it relates to any regional trends that may result from climate change effects. The establishment of an effective regional network is a bigger task than any single agency can undertake given the resources involved, and EPA's staff provided the needed leadership to establish and guide the partnership, as well as the scientific expertise on the study methods for characterizing any future changing conditions." – SRBC Executive Director Andrew Dehoff

EPA ORD is working with regional offices, states, tribes, river basin commissions and other entities to establish Regional Monitoring Networks (RMNs) for freshwater wadeable streams. The objectives of the RMNs are to collect long-term biological, thermal, hydrologic, physical habitat and water chemistry data to document baseline conditions across sites and detect long-term changes. Consistent methods are being used to increase the comparability of data, minimize biases and variability, and ensure that the data meet data quality objectives. Continuous sensors are being employed when possible. RMN surveys build on existing state and tribal bioassessment efforts with annual sampling of a limited number of sites that can be pooled at a regional level.

Pooling data enables more robust regional analyses and improves the ability to detect trends over shorter time periods. The collaborations across states, tribes and other entities resulted in the development of RMNs, some of which have collected data since 2012. Recently, EPA Regions 1, 2, 3 and 5, in coordination with their states and tribes, began developing RMNs for lakes and wetlands with the same objectives as the stream RMNs.

RMN data can be used for many purposes, over short and long-term timeframes. These applications include informing water quality and biological criteria development and protection planning priorities, refining lists of biological, thermal and hydrologic indicators, and detecting trends in commonly-used water quality and biological indicators. The RMN data also are important for detecting climate change effects in the context of biomonitoring. There are a number of climate change projections that are relevant to aquatic life condition, including increasing temperatures and changing frequency and magnitude of extreme precipitation events and frequency of summer low flow events. Managers will be able to use the monitoring data to help inform adaptive management.

Read the final report and fact sheet on *Regional Monitoring Networks (RMNs) to Detect Changing Baselines in Freshwater Wadeable Streams.*

Partners: Ohio River Valley Water Sanitation Commission (ORSANCO), an interstate commission representing 8 states (Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia) and the federal government
Challenge: Providing information to water utilities that will inform operating decisions and minimize impacts on water users resulting from spills within U.S. waterways
Resource: River Spill model in collaboration with Corona Engineering and American Water
Project Period: 2016 – Present

"The River Spill model has been used on several recent spills on the Ohio river and has predicted the actual times and concentrations very well. If accurate spill and river condition data is fed into the River Spill model, the model seems to accurately predict the resulting conditions downstream."
– ORSANCO Technical Program Manager Sam Dinkins

There are 25,000 navigable miles of inland waterways within the contiguous U.S., which transport an estimated 630 million tons of commodities valued at $73 billion annually. There are also hundreds of drinking water intakes that supply drinking water to 66% of American water consumers. Spills within U.S. waterways can threaten safe drinking water supplies, fire protection, commerce, and critical navigation activities.

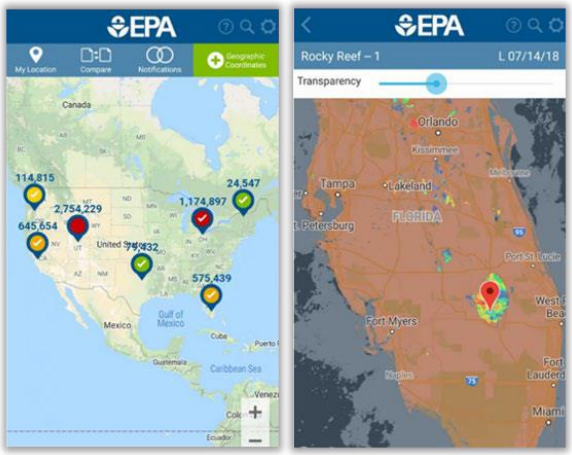
Given this challenge, EPA ORD researchers developed software that can run two-dimension models of spills in rivers. The software helps utilities decide if they should close their intake, add additional treatment, or access alternative water supplies, if available, while the worst of the spill plume passes. The River Spill model uses real time river data collected and distributed by the U.S. Geological Survey and the U.S. Army Corps of Engineers, and it can be run on a computer or handheld device. The model adds two-dimension definition and real-time updates to the U.S. Department of Defense's Technical Reachback Division's IC Water model.

The River Spill model is currently being tested by ORSANCO and American Water on spills that occur on the Ohio River and its tributary system. The initial results indicate good correlation between the model and actual spill conditions. Commercial entities such as Corona Engineering and American Water, which is the largest publicly held water company in the U.S., are partnering with EPA's Office of Water to test the River Spill model in West Virginia. The River Spill model is also being adapted to work on other river systems within the U.S. Current ongoing applications for the model include the Delaware River Basin and the Des Moines River. The model will allow any water utility utilizing source water from a river system to make the most informed operating decisions concerning spills within minutes of data input.

EPA is currently investigating various tracers in local streams that might be applicable for use in the Ohio River to help calibrate the results of the River Spill Model. Future enhancements to the River Spill Model include adding layers of GIS data such as bridge crossings, pipeline crossings, locations of oil and chemical refineries, and real time data on barge traffic. Additional related research is evaluating:

- Source water sensors' detection capabilities and water quality interferences
- Treatability studies on variable source waters

Partners: State environmental agencies or health departments
Challenge: Support the environmental management and public use of U.S. lakes and reservoirs by providing a capability of detecting and quantifying cyanobacteria harmful algal blooms using satellite data records
Resource: Satellite-derived measures of cyanobacteria, software and training in collaboration with the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and U.S. Geological Survey (USGS)
Project Period: Sentinel-3 satellite 2015 – 2023, Sentinel-2 satellite 2024+



"The images we've been receiving through the CyAN project have been tremendously helpful to the Utah DEQ Division of Water Quality (DWQ), providing the foundation for a wide range of useful outputs. It allows DWQ to better target field sampling and more efficiently use our limited resources to protect public health. Finally, images are easily shared with response agencies as a useful visual communication aid." – Utah Department of Environmental Quality, DWQ Standards & Technical Services Section Manager Benjamin Holcomb

Cyanobacteria blooms are an environmental and human health problem across the U.S. They are capable of producing toxins, odors, and surface scum that threaten the health of humans and animals, the quality of drinking water supplies, and the ecosystems in which they develop. Improving the detection process would help state environmental and health agencies better determine whether to post public advisories to protect aquatic and human health.

The Cyanobacteria Assessment Network (CyAN) project is a multi-agency effort among EPA, NASA, NOAA, and USGS to develop an indicator system using historical and current satellite data to quantify the temporal frequency, spatial extent, and magnitude of blooms in U.S. lakes. CyAN is providing daily and weekly cyanobacteria monitoring data to state environmental and health departments from the European Space Agency Sentinel-3 satellite, training opportunities, and software applications. As part of the CyAN project, EPA developed the CyAN app and CyANWeb, easy-to-use and customizable applications that provide access to algal bloom satellite data for over 2,000 of the largest lakes and reservoirs across the United States. Annual metrics that quantify the spatial extent, temporal frequency and occurrence as well as the original satellite data are publicly available through EnviroAtlas, Report on the Environment, and NASA's Ocean Color Web. These interfaces help local, state, and tribal water quality managers make faster and better-informed management decisions related to cyanobacterial blooms. During the CyAN app and webapp development, many partner states listed above participated in beta testing.

The original project concludes in 2023 and will transition in 2024 toward applying higher resolution Sentinel-2 Multi-Spectral Imager that can provide measures of chlorophyll in more than 270,000 lakes and all estuaries, adding US Army Corps of Engineers as a fifth federal partner. While the Sentinel-3 portion of the project will conclude, the data will continue to be made publicly available and reprocessed annually. CyAN will continue to engage states for feedback and testing.

WATER – STORMWATER

Partner: Ouachita River Valley Association, Cities of Monroe/West Monroe and Ouachita Parish (LA)
Challenge: Quantifying the true benefits of the Ouachita River ecosystem
Resource: Ecosystem services assessment, based on quantifying domains of human well-being, as a method for linking the ecosystem services provided by the Ouachita River to community priorities
Project Period: June 2017 – March 2020

"This study will be the first step in putting a true value on the Ouachita River….Currently, the Army Corps of Engineers only recognizes a river's value based on its transport tonnage….The Ouachita River is a source of potable water for the region or is a receiving body for the hundreds of commercial and public discharges into the river. This economic impact study will present the Ouachita River's true value, aiding in our efforts to obtain funding for all aspects of the river." – Ouachita River Valley Association Randy Denmon

While the Ouachita River offers economic, infrastructure and natural benefits to surrounding communities, the region and its cities, Ouachita Parish includes some of the most flood-affected areas in Louisiana. Waterways across the nation, including the Ouachita, are also facing reduced funding for river maintenance and bank stabilization. Resulting floods affect ecosystem services that provide recreational and economic benefits to rural areas. With decision support from EPA, the cities of Monroe and West Monroe explored ways to enhance community resiliency in the face of historic flooding along the Ouachita River.

EPA ORD, in partnership with the EPA Region 6 (South Central), convened a series of workshops in 2018 and 2019 for 35 participants representing federal agencies, community stakeholder groups, state and local government agencies, and universities. Together, these stakeholders prioritized flood mitigation projects along the Ouachita River that were expected to have the greatest benefit to human well-being. Their work was framed by EPA's Human Well Being Index, which helped participants evaluate the specific ecosystem goods and services the Ouachita River offers their community (such as water supply, storm-water discharge, and navigational, recreational, and educational opportunities). The project results were published in a report that now serves as a planning roadmap for flood resilience along the Ouachita River and a decision-making guide for federal, state, and local officials. Future phases of the work will determine the resilience outcomes of the selected projects as the community enjoys improved ecosystem goods and services and improved resilience against future floods.

Partners: Proctor Creek Watershed (in Atlanta, GA) residents and stakeholders
Challenge: Develop an easy-to-use resource that addresses community-identified concerns in the watershed
Resource: Interactive, online tool that provides environmental resources and important watershed information
Project Period: 2017 – 2020

"For years, Proctor Creek residents have elevated community concerns about environmental and health challenges in the watershed and invested decades of sweat equity to address those concerns. This Story Map helps to tell some of that story by centering both historical and ongoing challenges that have, in the past, and continue to plague the watershed today. Perhaps more importantly, it also offers tools that community members can pursue, in collaboration, with government and other stakeholders to help achieve a swimmable, fishable, playable Proctor Creek and a restored community and people." – West Atlanta Watershed Alliance, Co-Founder and Board Chairperson Na 'Taki Osborne-Jelks

Proctor Creek is an impaired waterway in Atlanta that experiences several overlapping environmental issues. The watershed has been troubled by frequent flooding, erosion, stormwater runoff, and pollution from illegal dumping. In addition, sewer overflows from the city's combined sewer system, which terminates in pipes that mix sewage and rainwater runoff with those from its sewage-only sanitary sewer system, have impacted the creek.

Beginning in 2017, EPA ORD researchers collaborated with EPA Region 4 (Southeast) to engage with residents and stakeholders in Proctor Creek to identify and address community concerns related to the local environment. A major outcome of the collaboration was the development of The Proctor Creek Watershed Story Map—an easy-to-use, interactive online tool that combines maps with narrative text, images, and multimedia content. Users can use the Story Map to explore concerns—such as flooding and water quality, urban heat islands, mosquitoes, and health—in the context of the potential for green infrastructure to provide solutions. Green infrastructure is a practice that uses plants, soils, and other natural features to manage wet weather impacts and reduce and treat stormwater at its source. Using green infrastructure can reduce a community's exposure to harmful substances and conditions, such as water pollution, flooding, air pollution, and heat. Green infrastructure can also provide opportunity for recreation and physical activity, improve safety, and promote community identity and a sense of well-being.

Since its release in 2020, the Story Map has been used to help community members engage as stewards of their watershed. The tool provides information and resources that the community can use to: 1) gain a better understanding of flooding, urban heat islands, mosquitoes, and green infrastructure and their impacts on health; 2) support efforts to address these issues within the watershed; 3) advocate for green infrastructure and health; and 4) help inform future decisions around green infrastructure, including areas in the Proctor Creek community that may benefit most from green infrastructure practices.

Read the fact sheet and news release on the Proctor Creek Story Map.

Partners: Audubon, Manomet, The Nature Conservancy, Southeastern Regional Planning and Economic Development District (Taunton, MA) and 9 townships in upper Taunton River Watershed
Challenge: Evaluate robust management practices to improve water quality, sustain water supply, and reduce flooding under varying weather regimes and projected landscape development using conservation and restoration of natural infrastructure and natural processes
Resource: Case study application of EPA's Watershed Management Optimization Support Tool (WMOST)
Project Period: 2016 – Present

"Manomet is partnering with EPA ORD to apply the WMOST model in the Taunton River Watershed in southeastern Massachusetts. The WMOST analysis will provide insight on the nutrient pollution ramifications of different degrees of protection of the green infrastructure network identified by Manomet and project partners. Without the support of EPA ORD, the application of WMOST to quantify the value of the green infrastructure network would not have been possible." – Manomet Senior Program Leader Climate Services Eric Walberg

The Taunton River in Massachusetts is a designated Scenic River with significant natural resources, but it is located in a rapidly developing region with water supply issues and degrading water quality. The state of Massachusetts has recommended conservation objectives for the watershed that include creation of public forums on the economic value of purchasing (conservation) lands to control municipal budgets and the development of a land purchase priority system.

Based on this recommendation, EPA ORD is assisting the non-governmental organization (NGO) Manomet with an application of the Watershed Management Optimization Support tool (WMOST) to evaluate costs and benefits of natural and nature-based green infrastructure in protecting property and drinking water quality. EPA ORD will also help communities in the upper Taunton by demonstrating a new version of WMOST designed to support consideration of multiple objectives. This will provide stakeholders information to evaluate tradeoffs. In addition, this case study is providing information that will be used by the NGOs and regional planning commission for training workshops on green infrastructure in surrounding communities.

Initial results of WMOST and the multi-objective version (GreenOpt) applications to the Upper Taunton have been published. EPA Region 1 (New England) is using this as the basis for a more in depth analysis of the upper Taunton with funding from the Southeast New England Program (SNEP). Based on stakeholder feedback, EPA ORD has shifted focus to the Assawompsett Ponds and Upper Nemasket River watersheds within the Taunton River Basin, applying WMOST to find robust solutions to flooding and sustainable water supply issues under both current and future climate scenarios.

Partners: Maryland Department of the Environment (MDE), Montgomery County (MD), City of Rockville (MD)
Challenge: Identifying the most cost-effective suite of stormwater best management practices to meet both local sediment total maximum daily loads (TMDLs) and downstream targets for Chesapeake Bay TMDL
Resource: Case study application of EPA's Watershed Management Optimization Support Tool (WMOST) version 3
Project Period: 2019

"One of Maryland's greatest challenges, and opportunities, is to ensure its Phase I MS4's meet permit and TMDL restoration requirements in ways that are affordable and sustainable. This study, in a small urban watershed, is a cooperative effort among state, county and city governments and EPA to develop a balanced implementation strategy. EPA ORD's modeling tools used in this study have unique features such as stormwater BMP runoff reduction estimates and cost optimization modules to help us achieve environmental results, while maximizing savings for ratepayers." – MDE Secretary Ben Grumbles

The Maryland Department of the Environment (MDE) has identified the Cabin John Creek watershed in Montgomery County, MD, as impaired by sediments, nutrients, bacteria, chlorides, sulfates and impacts to biological communities. Cabin John Creek drains to the Potomac River, part of the Chesapeake Bay watershed. To help address these impairments, MDE is providing guidance to local communities about applying cost- effective best management practices (BMPs) to meet regulatory targets set by the total maximum daily loads (TMDLs) for sediments.

EPA ORD is applying version 3 of EPA's Watershed Management Optimization Support Tool (WMOST) to the Cabin John Creek watershed to determine the most cost-effective suite of stormwater BMPs (including green infrastructure) for controlling sediment loading. This phase of the work has been completed with publication of the final report. ORD is continuing to partner with MDE in applying WMOST to a series of urban watersheds near Baltimore to determine the most cost-effective approaches to maintain stream thermal regimes, considering both riparian zone restoration and stormwater BMPs.

Watershed managers are using the results of WMOST calculations to identify solutions that will meet both local sediment targets and downstream loading targets for total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN) for the entire Chesapeake Bay watershed.

Read the final report titled *WMOST v3 Case Study: Cabin John Creek, Maryland*.

Partners: Minnesota Department of Health; University of Minnesota
Challenge: Obtaining water quality data and best technologies for informing processing and treating stormwater reuse
Resource: Water quality assessments of stormwater harvested for landscaping and agricultural irrigation near four midwestern towns
Project Period: 2019 – 2020

"This project will help Minnesota to keep moving forward with stormwater reuse as a tool to conserve water resources and improve surface water quality while protecting public health."
– Minnesota Department of Health, Engineer Anita Anderson

There is limited data to determine the suitability of stormwater for direct reuse in surface irrigation systems, either on a commercial or residential scale. In locations with limited infiltration capacity or stressed water supplies, water reuse can conserve resources and benefit surface water quality. However, it is also important to ensure that reuse projects are implemented in ways that protect human health and the environment.

EPA ORD, in collaboration with the Region 5 (Great Lakes) and the Minnesota Department of Health, planned and implemented stormwater sampling events to determine water quality impacts on irrigation and agricultural stormwater reuse. Specifically, stormwater samples were collected in Chicago, IL; Cincinnati, OH; Cleveland, OH; and Minneapolis, MN, in August 2019 for physical, chemical and microbial indicators and in October 2020 for pathogen samples. Samples were collected from various collection areas including 1) rooftop water collection tanks, 2) permeable pavement catch basins, 3) mixed use (roofs, parking lots) urban underground cisterns and storage tanks, and 4) mixed use (roofs, vegetated lands) suburban ponds and farm wetlands. Reuse site characteristics of interest include age, tributary area, land use, end-use of water, size and type of storage, and type of treatment (e.g., sediment screens, filtration, chlorination, ultraviolet disinfection).

The research provided relevant information on the extent of physical, chemical and microbial contamination of reuse waters and the effectiveness of filtration and disinfection technologies to reduce public health risks.

Partners: Missouri Department of Natural Resources (DNR); City of Kansas City
Challenge: Defensible models to reduce sewer overflows and improve regional water quality in a cost-effective manner
Resource: Storm Water Management Model
Project Period: 2016

"States are focusing on ways to address storm water and tools like the Storm Water Management Model are essential to a successful outcome. This model makes analyses of best management practice options readily available. In addition, the climate adjustment addition helps cities reach sustainable solutions." – Missouri DNR former Director Sara Parker Pauley

States and municipalities heavily use EPA ORD's Storm Water Management Model (SWMM) to model stormwater flows and the performance of water infrastructure in urban areas. SWMM's Climate Adjustment Tool can also be used to consider potential future changes in temperature and precipitation that will influence the runoff volumes. SWMM is the engine for the basis of almost all future water infrastructure design. SWMM runoff and flow predictions are used for multi- billion-dollar decisions for foreign, federal, state and municipal governments. The city of Kansas City, Missouri, designed its $10 million, 100-acre Middle Blue River pilot on SWMM predictions, and the City intends to design any future green infrastructure controls using SWMM.

Read the final report titled *EPA's Summary Report of the Collaborative Green Infrastructure Pilot Project for the Middle Blue River in Kansas City, MO.*

Partner: Vermont Department of Environmental Conservation (DEC)
Challenge: Prioritization of developed areas for retrofit stormwater best management practices
Resource: High resolution impervious cover data for Vermont watersheds
Project Period: 2017 – 2018

"The impervious cover data we received from EPA saved me one to two days of work in our efforts to bring increased awareness of the negative impacts on water quality of impervious surfaces which are directly connected to surface waters in developed areas. Increased awareness of problem areas helps us work with municipalities to mitigate impacts." – Vermont DEC, Watershed Management Division Hank (David) Ainley

EPA ORD has developed methods for high accuracy classification of high resolution (1-meter) imagery for impervious cover from the U.S. Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) imagery for impervious cover with the understanding that such data are needed by states and local communities for infrastructure and development planning. Vermont DEC was looking for mapping data to quickly prioritize developed areas for stormwater best management practices retrofits. ORD was able to provide copies of the in-house developed high-resolution impervious cover data, developed in-house, to Vermont DEC's Watershed Management Division. Results from this work were recently published.

Vermont DEC staff used these data in conjunction with mapped sewer drainages to quantify connected impervious cover in municipalities with wastewater treatment plants. Vermont DEC also compared the condition of streams in watersheds with differing levels of connectivity and used this information to inform decision on where to retrofit. Together Vermont and EPA are exploring ways in which ongoing ORD research on watershed-scale effects of nature-mimicking infrastructure development can complement the state's efforts.

Partners: Alliance for Chesapeake Bay, Chesapeake Bay Foundation, Dauphin County Conservation District, Lancaster County Clean Water Consortium, Lancaster County Conservancy, Lebanon County Conservation District, Pennsylvania State University and Susquehanna River Basin Commission
Challenge: Managing stormwater treatment systems to protect and to restore water quality in the Chesapeake Bay
Resource: Center for Green Infrastructure and Stormwater Management
Project Period: 2016 – 2018

"An ounce of stormwater pollution prevention is worth a pound of cure, particularly when it adds multiple benefits through green infrastructure and natural treatment systems. The Center helps Chesapeake Bay states and stakeholders find solutions to some of our most challenging water quality problems through science-based innovation and collaboration." – Maryland Department of the Environment, Secretary Ben Grumbles

The EPA ORD-supported Center for Green Infrastructure and Stormwater Management was established to conduct interdisciplinary research to understand and to influence how decisions are made at multiple spatial and jurisdictional scales to manage stormwater treatment systems that protect and restore water quality in the Chesapeake Bay. By the time indicators of impairment are measured within the Chesapeake Bay, the opportunity for adaptive management to alleviate the degradation of water quality may have already passed. It is therefore imperative to identify headwater landscapes that are particularly vulnerable to stress from high pollutant loads, population growth and changes in land management.

The Center serves as a focal point to bring together stakeholders and researchers from multiple disciplines to improve stormwater management in urban and suburban settings; to reduce pollutant loads of nutrients, sediments, organics and metals; and to minimize stormwater volume and energy use across a range of storm event magnitudes. To accomplish these objectives, the Center identified the cognitive and institutional barriers preventing communities from adopting green infrastructure measures to manage stormwater. Additionally, the Center designed green infrastructure and developed methods to help stakeholders visualize alternative infrastructures. It modeled the environmental and financial benefits of these alternative infrastructures and served as a forum for stakeholder discussions.

More information on the research projects at the Center for Green Infrastructure and Stormwater Management.

WATER – WASTEWATER/WATER REUSE

Partners: State of California and San Francisco Public Utilities Commission (SFPUC)
Challenge: Providing sufficient, quality water to meet increasing demands
Resource: Assessment modeling for introduction of novel water reuse technologies
Project Period: 2017 – Present

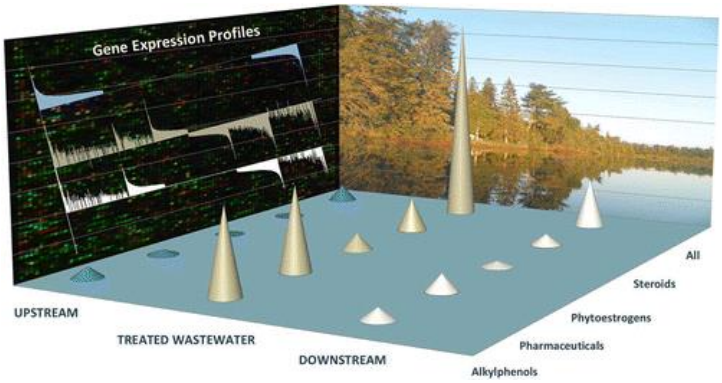
"SFPUC values the research being done by EPA ORD in the field of decentralized non-potable water systems. ORD is building upon completed research to provide much needed, additional support—in terms of characterizing pathogen concentrations and identifying potential surrogates that can be used to monitor treatment process performance—towards the goal of reducing exposure to pathogens." – SFPUC, Director of Water Resources Paula Kehoe

Through our collaborations with the state of California and the SFPUC, EPA ORD is developing and testing assessment methods to identify optimum technologies for using alternative waters (sources) for non-potable and potable purposes. Changes in drinking water and wastewater management strategies to meet state and local demands has led to new approaches (e.g. membrane bio-reactors) for developing and implementing additions and improvement to current water treatment and delivery schemes. In addition to these approaches, there is also interest in utilizing alternative waters (sources) in community water systems. To utilize these alternative waters, communities are now faced with additional challenges to ensure the same water quality is delivered, as well as optimizing resource recovery and system efficiency when using alternative waters for non-potable and potable purposes.

SFPUC leads an effort to implement decentralized non-potable water systems that involves a group of stakeholders from across the country, including a range of water utilities (Austin, Denver, Los Angeles, Portland, Seattle and Washington, DC) and public health departments (California, Colorado, Hawaii, Minnesota, Washington and New York City). EPA ORD is assisting by developing and assessing the risk-based log reduction targets related to fit-for-purpose water use. This integrated assessment also includes life cycle costs, and potential environmental (particularly energy) and human health impacts. EPA ORD's work will provide the state and various utilities and public health departments with a system-level approach and framework that will quantitatively evaluate the tradeoffs that exist among alternative processes and identify which configuration delivers a robust and sustainable water system design.

More information on EPA's research on non-potable water reuse can be found here.

Partners: Minnesota Pollution Control Agency (MPCA), Western Lake Superior Sanitary District
Challenge: Complexity of wastewater treatment plant (WWTP) effluents and lack of available water quality guidelines or reference values for many of the chemicals
Resource: Biological effects-based monitoring of WWTP effluents using new science tools in collaboration with the St. Cloud State University, the University of St. Thomas, the National Park Service and USGS Toxic Substances Hydrology Program
Project Period: 2010 – 2016



"The information generated through this collaborative work will help MPCA and local wastewater treatment facilities better address the contaminants in sewage treatment discharges. Managing impacts of chemicals in surface waters is especially important for MPCA as Minnesotans highly value lakes and streams."
– MPCA, John Linc Stine (former Commissioner)

While wastewater treatment infrastructure has been critical for the improvement of water quality nationwide, effluent from wastewater treatment plants (WWTPs) often represents a highly complex mix of chemical contaminants whose composition can vary daily and seasonally with human inputs as well as plant operations. Due to both their complexity and the lack of available water quality guidelines or reference values for many of the chemicals found in WWTP effluents, these sources pose a challenge for determining what biological impacts these effluents may cause, which chemicals may be driving those responses, and where and how to best allocate limited resources available for monitoring and management.

In collaboration with partners at the Western Lake Superior Sanitary District in Duluth, Minnesota, MPCA and other federal and academic partners, EPA ORD studied WWTP effluents discharging into a diversity of surface waters across Minnesota, ranging from urban and agriculture influenced watersheds, to large Great Lakes tributary streams, to a highly pristine national scenic waterway. The group employed novel tools akin to clinical diagnostic tests to look at fish caged in effluent impacted waters, and to estimate and measure both potential and observed biological effects of tens to hundreds of chemicals. By comparing the observed effects of these complex mixtures to expected effects housed in on-line databases, the scientists can better identify which chemicals and biological effects might be of greatest concern, and also identify whether unknown constituents may be contributing significantly to the responses. With this information, decision makers in Minnesota will be able to strategically target follow up investigations that can generate solutions to these challenges.

Partners: NC Department of Environmental Quality, City of Charlotte, City of Raleigh
Challenge: Acceptance of bio-contaminated wastewater by Publicly Owned Treatment Works (POTWs)
Resource: Technical support around pathogens in wastewater infrastructure
Project Period: 2014 – present

"The question of how wastewater plants deal with bio- contaminated waste needs to be addressed before a potential health emergency surfaces. EPA's proactive work to assist wastewater operators before the next emergency occurs is not only prudent, but critical in order to protect public health." – NC DEQ former Assistant Secretary Sheila Holman

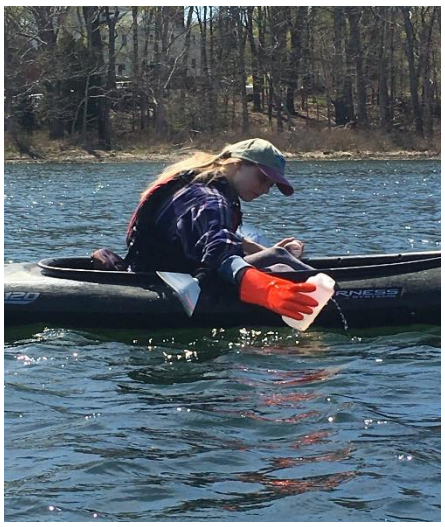
In October 2014, EPA held a forum on high consequence pathogens in wastewater infrastructure for state and POTW representatives. The forum focused on providing recommendations, technical information, and potential solutions to the wastewater industry, particularly for emergencies.

The forum was organized around the following questions: How do we deal with wastewater contaminated with biological agents such as *Bacillus anthracis* or Ebola virus? What is needed/required for utilities to accept bio-contaminated wastewaters? What sorts of tests, protocols and regulatory guidance are needed? What is needed for permit authorities in NC to guide/allow utilities to accept these wastes? How should these (tests, protocols, and regulatory guidance) be designed or implemented? Who should design and evaluate these? Are there other "simpler" tests and protocols? What is needed to address concerns and issues raised by the public, wastewater workers and operators? What are the data gaps and what type of research is needed?

As a result of this forum, EPA and the Water Environment Research Foundation (currently known as the Water Research Foundation) held a national workshop on this topic in 2016. In turn, this led to several research projects being planned and implemented to address the key research gaps and needs brought up in the workshop. Read the published report from the 2016 workshop titled *Collaborative Workshop on Handling, Management, and Treatment of High-Consequence Biocontaminated Wastewater by Water Resource Recovery Facilities.*

Since then, EPA is investigating data needs that, if filled, would assist wastewater plant operators in making decisions about whether and how to accept wastewater contaminated with high consequence pathogens (e.g. anthrax bacteria, Ebola virus) during an emergency. EPA is also in the process of performing research projects to address needs associated with POTW acceptance of wastewater potentially contaminated with such pathogens.

Partner: Town of North Kingstown (RI) Departments of Water and Public Works
Challenge: Assessing the impact of sewering on coastal water quality
Resource: Technical support in collaboration with the U.S. Geological Survey (USGS)
Project Period: 2018 – 2020



"The town of North Kingstown's main village, Wickford, is a densely settled area on the coast with many houses built between 1780 to 1830. Although direct discharges to the water and most of the cesspool systems have been eliminated, rising sea level and older, inefficient septic systems continue to impact the receiving waters. Sanitary sewers to the business district of the village are being installed. The town needs help persuading residents of the need to extend sewers to the residential areas. The analysis and assessment by the EPA showing improvement of the water quality would really drive the importance of sewers." – North Kingstown Town Engineer N. Kim Wiegand, PE

Many areas rely on septic systems installed at individual homes and businesses to treat most of their wastewater. These systems were designed primarily to remove harmful bacteria, and most allow the bulk of the nutrients in the waste to flow via groundwater into streams, ponds or coastal waters where they can cause problems such as low dissolved oxygen (which can harm fish populations) and harmful algae blooms. To solve this problem, many coastal communities are installing sewers to intercept, treat and discharge the waste to less sensitive areas. These projects are expensive for taxpayers and few studies have documented the beneficial effect of sewering on water quality in the receiving waters, which is of interest to communities that invest in them.

Wickford, a small village in North Kingstown, RI, is in the process of installing sewers and hoping to secure and maintain support for their project within the community. EPA ORD researchers have sampled the waters around the town since early 2018, measuring nutrients, dissolved oxygen and several tracers of wastewater and in a collaboration with EPA Region 1 (New England) and USGS starting in 2020, mapping groundwater and associated nutrient flow into the cove system around Wickford. While it is too early to assess if water quality is improving, EPA ORD and its partners are creating a baseline for comparison after the sewering is finished. EPA ORD is working with the Town of North Kingstown to document the progress of the sewering and remediation of water quality problems in the coves surrounding Wickford (e.g., algae covering cove bottoms and low dissolved oxygen conditions, particularly at night during the summer), and to develop educational materials about the impact of nutrients on coastal waters and the impact of sewering in the coves around Wickford. Eventually the town will use the generated data to determine if sewering has improved local water quality and demonstrate to residents how their investment is paying off in terms of local environmental improvement.

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