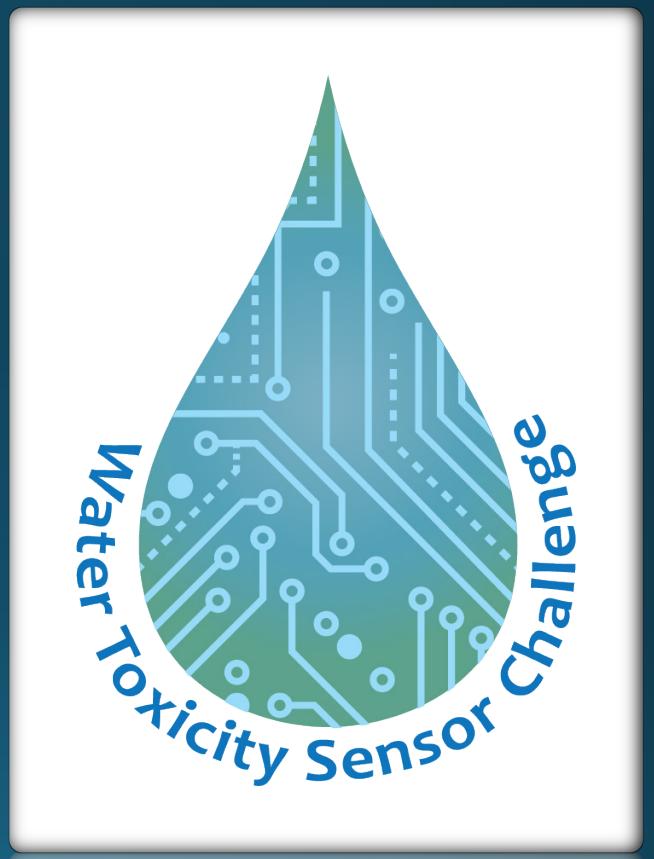
Challenge Launch Webinar

June 8, 2021

Water Quality Monitoring for the 21st Century: A Sensor to Measure Toxicity



Agenda

- Introduction and background
- Perspectives from partnering organizations
- Challenge details
- Questions

Presenters

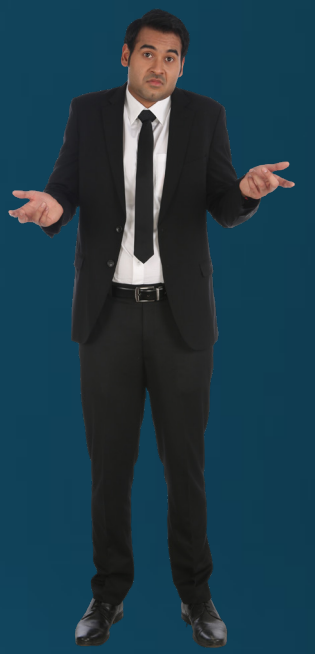
Slide presenters in order of appearance:

- **Eunice Varughese** - US EPA's Office of Research and Development (ORD)
- **Ann Grimm** - US EPA's Office of Research and Development (ORD)
- **Timothy Reilly** – US Geological Survey's Environmental Health Program
- **Gregory Doucette** – National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Service
- **Valerie Divito** – U.S. Army Medical Research and Development Command, Military Operational Medicine Research Program
- **Erin Partlan** – The Water Research Foundation
- **Ying Hong** – Greater Cincinnati Water Works

Q&A Additional Resources

- **Denice Shaw** – US EPA's ORD (EPAs Challenge Lead)

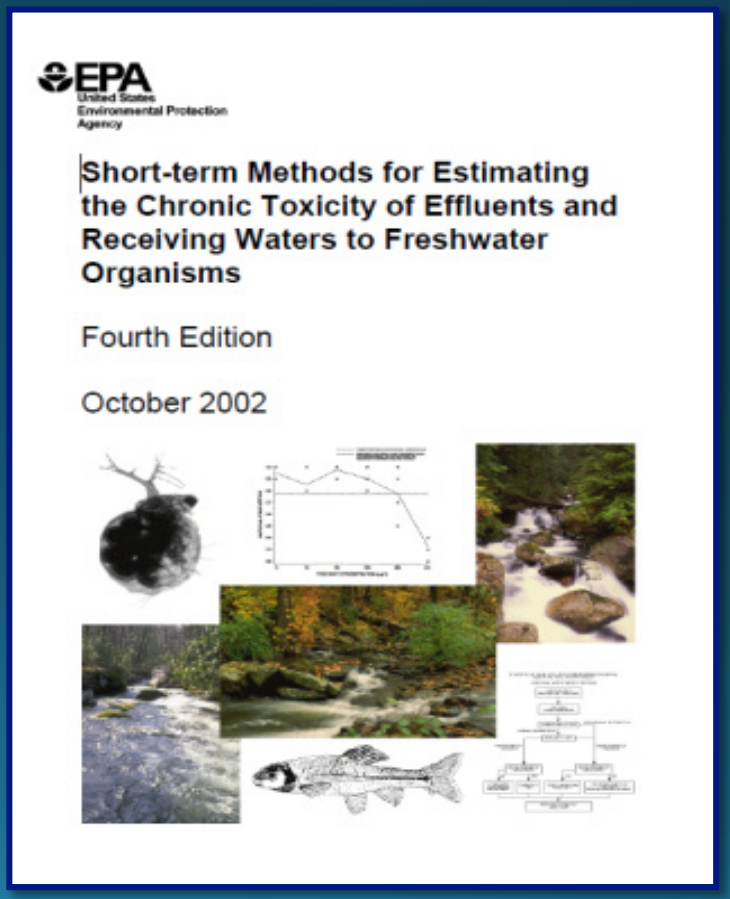
What is the Problem?



- Water pollutants create exposure concerns for humans and the environment.
- Monitoring the increasing number of pollutants in source waters is an ongoing concern for water treatment systems and water resource managers.
- Current methods for detecting and identifying many of these contaminants are expensive, time-consuming, and require the use of specialized analyses by dedicated laboratories.
- If the identity of the potential contaminant is unknown, this process becomes even more complex and cost prohibitive.

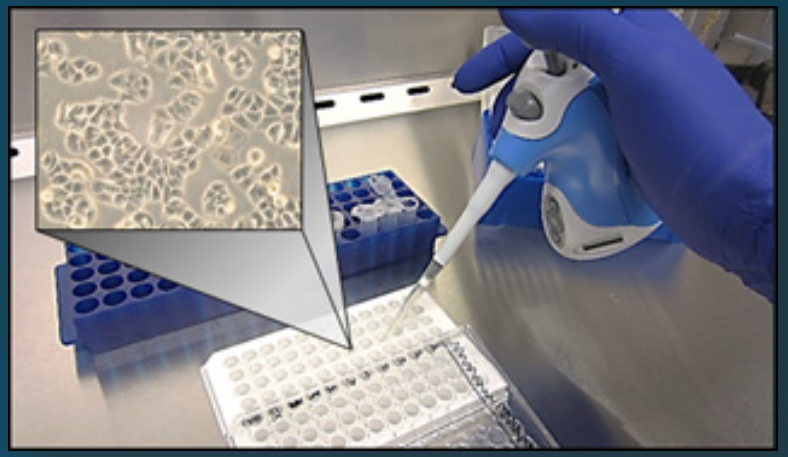
Current Methods-Whole Effluent Toxicity Tests

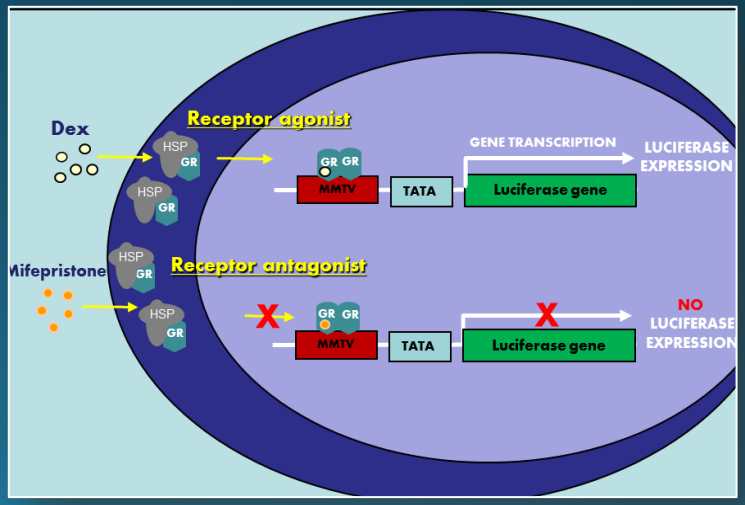
- Water's equivalent to a "canary in a coal mine"
- Compare the effect of treated wastewater and a control to see the effect of the wastewater on an organism
- This is a sensitive method, however there are limitations
  - Different species may have different sensitivities
  - Cause of the effect may be hard to identify



In vitro Bioassays

- Living cells/tissues instead of whole organisms are tested for responses to toxicants or groups of toxicants.
- Often involves engineered receptor-reporter gene constructs
- Cumulative measurements of biological activities
- Lab method





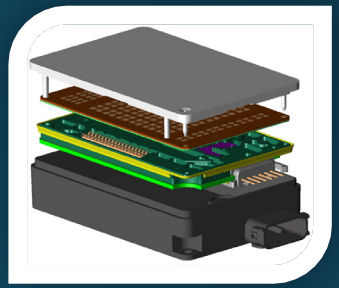
A New Kind of Tool is needed

- A sensor that allows for the detection of multiple, biologically active contaminants which trigger one or more specific toxicity pathways is needed.

- If developed, this sensor would be of great interest to the drinking water and wastewater industry. It also has potential applications in other water matrices including ambient and recreational water.

Why a Sensor Challenge?

- We want a sensor that can quantitatively measure certain biological activities of molecules/chemicals in water



- Technological advances in bioengineering and synthetic biology may have already developed the tools required to meet our needs but have not applied them to develop a Water Sensor.

- The challenge opens the opportunity to adapt these technologies on a sensor platform.

The Challenge – Shared Vision by Partnering Organizations

- The goal of this Challenge is to produce a design concept for a biologically-based effects monitor/sensor capable of responding to multiple environmental contaminant exposures that result in toxicity or adverse health effects when host organisms are exposed.
- The current Challenge is looking for:
  - Innovative concepts and solutions
  - Sensor that makes quantitative measurements of activities associated with toxicity pathway(s)
  - Detects the "effects" of chemical pollutants and natural toxins from various water types (e.g. surface waters, drinking water, wastewater effluent, and landfill leachate) at levels of concern, but does not need to identify the specific chemical(s)
  - Additionally, a sensor that can be adapted to a field-portable platform would be ideal.

Federal Perspectives

US Environmental Protection Agency

- To support the protection of water quality, ORD conducts research to produce scientific tools and information that can be used to reduce water pollution.

- A priority for EPA is to support technology development toward data that are of known quality and help establish best practices for the use of sensors and their data.

Federal Perspectives

US Geological Survey

- Comprehensive measurement of environmental contaminants and pathogens in environmental and biological matrixes are difficult, time-consuming, and expensive.
- Effect-based monitoring using in-situ sensor systems promise to be a powerful compliment to existing water quality monitoring efforts.
- Toxicity sensor data could be used to inform non-target chemical analysis, compliment screening tools, and aide in the interpretation of targeted environmental chemical analysis.
- Robust toxicity sensors could reduce our dependency on animal-based toxicity testing methodologies.

USGS
science for a changing world

Federal Perspectives

National Oceanic and Atmospheric Administration

- NOAA combines water quality information with weather and climate data to address issues related to the impact of pollutants on the marine environment, including estuarine 'nurseries' for fisheries
- The Agency aims to advance R&D for water quality and algal bloom toxicity forecasting, and invest in key technologies, including critical observing systems, to minimize health risks and reduce socioeconomic impacts
- Field-deployable, effect-based toxicity biosensors will provide a valuable 'front-line' monitoring capability to support targeted detection technologies and enhance science-based decision support tools

Federal Perspectives

US Army Medical Research and Development Command

- Various user communities would benefit from the transition of environmental hazard research into knowledge and technology such as water toxicity sensors that would mitigate degradation on health, readiness, and performance due to environmental hazards
- In particular, those operating in, on, or around contaminated water and the use of indigenous water sources would be able to potentially use new capabilities to detect the presence of hazardous substances and act to prevent illness resulting from using these water sources.

(https://momrp.amedd.army.mil/overview/environmental-health-and-protection)

National Research Perspective

The Water Research Foundation

- Mission: Advancing the science of water to improve the quality of life.
- Emerging contaminants are a pain point for the water sector as it takes months and years to develop a thorough understanding of presence, fate, transport, and adverse health effects.
- High throughput water quality screening has the potential to enable advances in numerous water treatment applications, including drinking water, water reuse, and source water protection.

Local Perspective

Greater Cincinnati Water Works

- GCWW was the first water security pilot system in 2005. The current water security monitoring system covers multiple WQ parameters but relies on a limited number of chemical detection methods, many of which have detection limits well above biologically relevant levels.

- An effective biosensor monitoring system would enhance GCWW's capabilities to quickly detect and respond to a wider range of contaminations and minimize public health impacts

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Challenge: Specifications to be Achieved

"Must Have" Criteria –

- The system must measure the activation of one or more toxic pathways that are linked to adverse health outcomes caused by environmental pollutants in water, such as hepatic toxicants, endocrine disrupting compounds, pesticides, heavy metals, and/or other contaminants of health concern.
- If multiple toxicity pathways are targeted, the system should provide information as to which pathway is activated to produce a signal.
- The system should function in a range of chemical concentrations of relevance to human health. As proof of concept, positive controls can be used to define lower and upper limits of response and quantification for each pathway (i.e., the linear dynamic range (LDR)).

Challenge: Specifications to be Achieved

"Must Have" Criteria, continued –

- The system should be functional under conditions normally associated with various water types (e.g., varying levels of microorganisms, pH, alkalinity, hardness, humic and fulvic acids, dissolved solids, turbidity, etc.), and account for associated matrix effects on sensor response. That is, the design should be compatible with operation and deployment of the sensor in field operations as opposed to a clinical setting.
- The system should be designed in such a way that the eventual final product would incorporate internal (possibly automated) quality assurance protocols (e.g. calibration) and define precision and accuracy for signals reported by the sensor.
- All sample handling/preparation requirements should be minimal and/or accounted for in the sensor design (i.e., automated).

More Specifications

Additional "Nice to Have" Criteria

- Demonstrated performance in a controlled (i.e., laboratory) setting for detection of various contaminants via perturbations of pathway(s).
- Provide continuous measurements to remote observers in real time.
- Extended deployment (weeks to months), with little-to-no maintenance required during deployment, prior to performance declining to below specified tolerance limits.
- Automatic self-detection of degradation of performance with alerts to the operator of this condition.

Ineligible Solutions

Sensors that measure basic water quality parameters such as pH, turbidity, nutrients, conductivity, etc. are well established, but do not provide direct assessments of toxicity pathways associated with specific types or classes of contaminants.

Challenge Process and Awards

All entries must be submitted via the InnoCentive Website:
https://innocentive.wazoku.com/#/challenge/89cf14146dbe4d40a5a94ea823d34c05

Timeline for Stage I

Launch:	*April 27, 2021*
Closing:	*July 26, 2021, midnight*
Judging:	*July-September 2021*
Award:	*Fall 2021*

- **Stage I:** Designs for sensors to detect toxicity pathway activation in water systems. *Award: Up to 3 awards of $15,000 each for participants that develop a sensor design*
- **Stage II:** A challenge to develop and test a prototype of a deployable toxicity sensor may occur, depending on the results of the phase I.

Evaluation of Submissions

- Each submission will include a written proposal (may include a video and illustration)
- After the Challenge submission deadline, proposals will be judged by a panel convened by EPA
- The panel will recommend winning solutions and the EPA will make final selections
- All persons or entities that submit a proposal will receive a high-level evaluation and be notified as to the status of their submission
- EPA decisions cannot be contested.

Questions?

- Website for the Challenge:
  https://innocentive.wazoku.com/#/challenge/89cf14146dbe4d40a5a94ea823d34c05

- Technical Questions
  Use the "Messages" tab in the Wazoku platform (this will appear after you accept the Challenge Specific Agreement)

- Questions related to the platform
  support@wazoku.com

- Social Media
  #WaterToxicitySensor

Water Toxicity Sensor Challenge