



# SAFE AND SUSTAINABLE WATER RESOURCES RESEARCH PROGRAM

**U.S. EPA Office of Research and Development**

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National Program Director

SAB Pre-meeting, July 17, 2014





# ORD Research Programs

## Air, Climate & Energy



## Sustainable & Healthy Communities



## Homeland Security



## Chemical Safety for Sustainability



## Human Health Risk Assessment



## Safe & Sustainable Water Resources



# Aligning Research with EPA Strategic Goals

## Cross-Agency Strategies

- Sustainable Future
- Visible Difference in Communities
- New Era of Partnerships
- High-Performing Organization

## EPA Goals 2014-2018

- Addressing Climate Change and Improving Air Quality
- Protecting America's Waters**  
Clean Water Act  
Safe Drinking Water Act
- Cleaning Up Communities and Advancing Sustainable Development
- Ensuring the Safety of Chemicals and Preventing Pollution
- Enforcing Laws, Ensuring Compliance

## Research Programs

- Air, Climate & Energy
- Safe and Sustainable Water Resources**
- Sustainable and Healthy Communities
- Chemical Safety for Sustainability
- Human Health Risk Assessment
- Homeland Security





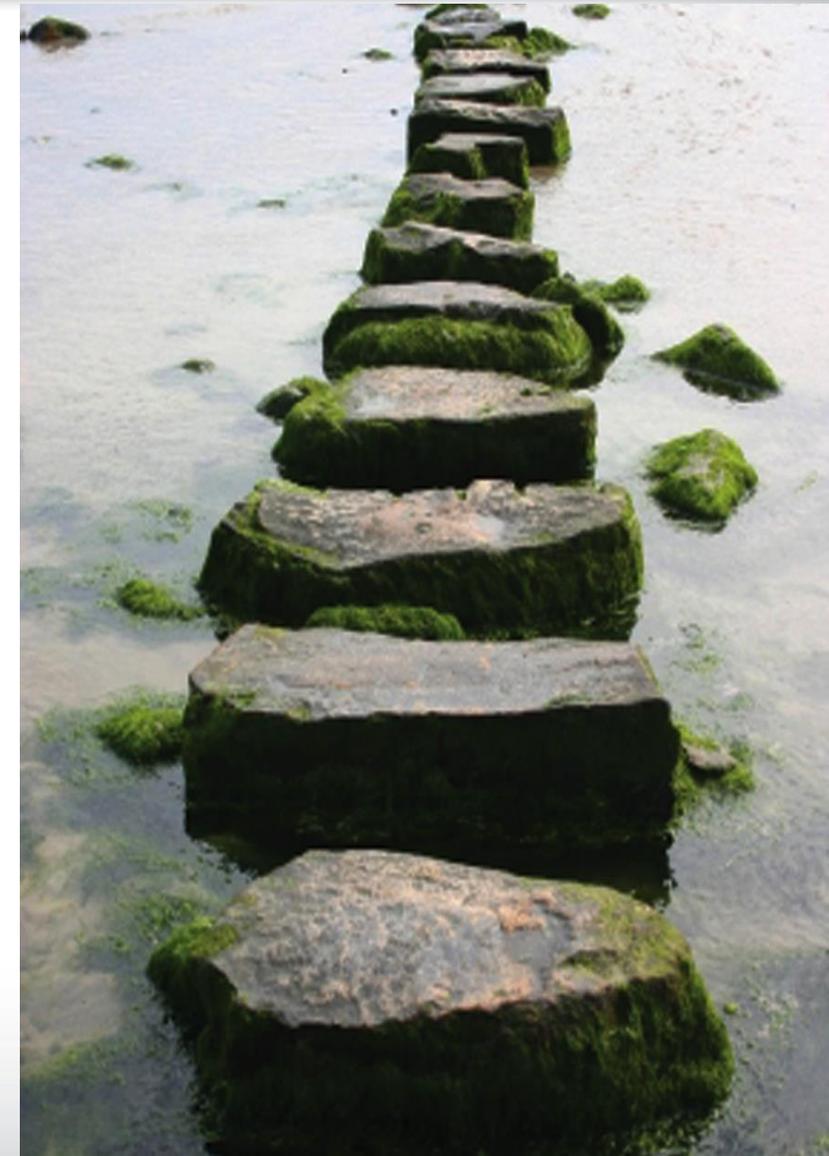
# Strategic Planning

## What is a **Strategic Research Action Plan (StRAP)**?

- Describes research program for internal and external audiences
- Developed in consultation with advisors
- Serves as our planning document; guides allocation of resources (\$ and people)

## Early Input from **SAB** and **BOSC**

- Preliminary Draft: just beginning 2016-2019 StRAP updates
- Kicks off the year long process with EPA partners and stakeholders
- High level strategic plan; are we heading in the right direction?





# Input from Partners, Stakeholders, Experts

## Other Federal Agencies

- USGS, USDA, USFWS, USACE, USBR, DOE, DOD, NFS, NPS, NOAA, NASA, NSF
- OSTP multiagency workgroups
  - Council on the Environment and Natural Resources and Sustainability (CENRS)
  - Subcommittee on Water Availability and Quality (SWAQ)

**EPA Office of Water and Regional Offices (1-10)**  
**(Priorities, Technology Innovation Blueprint)**

<ul style="list-style-type: none"> <li>• Air and Radiation</li> <li>• Chemical Safety and Pollution Prevention</li> <li>• Solid Waste and Emergency Response</li> <li>• Enforcement and Compliance Assurance</li> </ul>	<ul style="list-style-type: none"> <li>• International and Tribal Affairs</li> <li>• Children's Health Protection</li> <li>• Policy /Natl. Center Env't. Economics</li> <li>• Environmental Justice</li> </ul>
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**International:**

- Global Water Research Coalition
- Singapore PUB, Australia, China

**Associations and Foundations**

- WERF/WEF, ACWA, AWWA, AWRA, NGWA, others

**States (ECOS/ERIS) and Municipalities**

**Science Associations, Conference, Workshops, etc.**

**Agency advisory groups (SAB, BOSC)**

**National Academies**

**National Programs**

- Safe and Sustainable Water Resources
- Air, Climate & Energy
- Sustainable and Healthy Communities
- Chemical Safety for Sustainability
- Human Health Risk Assessment
- Homeland Security

**NCER**

- Academia/NGOs

**Water Technology Innovation Cluster**

- UPTeCH
- CitiLogics
- Sandia
- No. Kentucky Water District
- Cambrian

**ORD Immediate Office of the Assistant Administrator**

## Labs and Centers

National Health and Environmental Effects Research Laboratory	National Exposure Research Laboratory	National Center for Environmental Assessment	National Risk Management Research Laboratory	National Center for Environmental Research	National Homeland Security Research Center	National Center for Computational Toxicology
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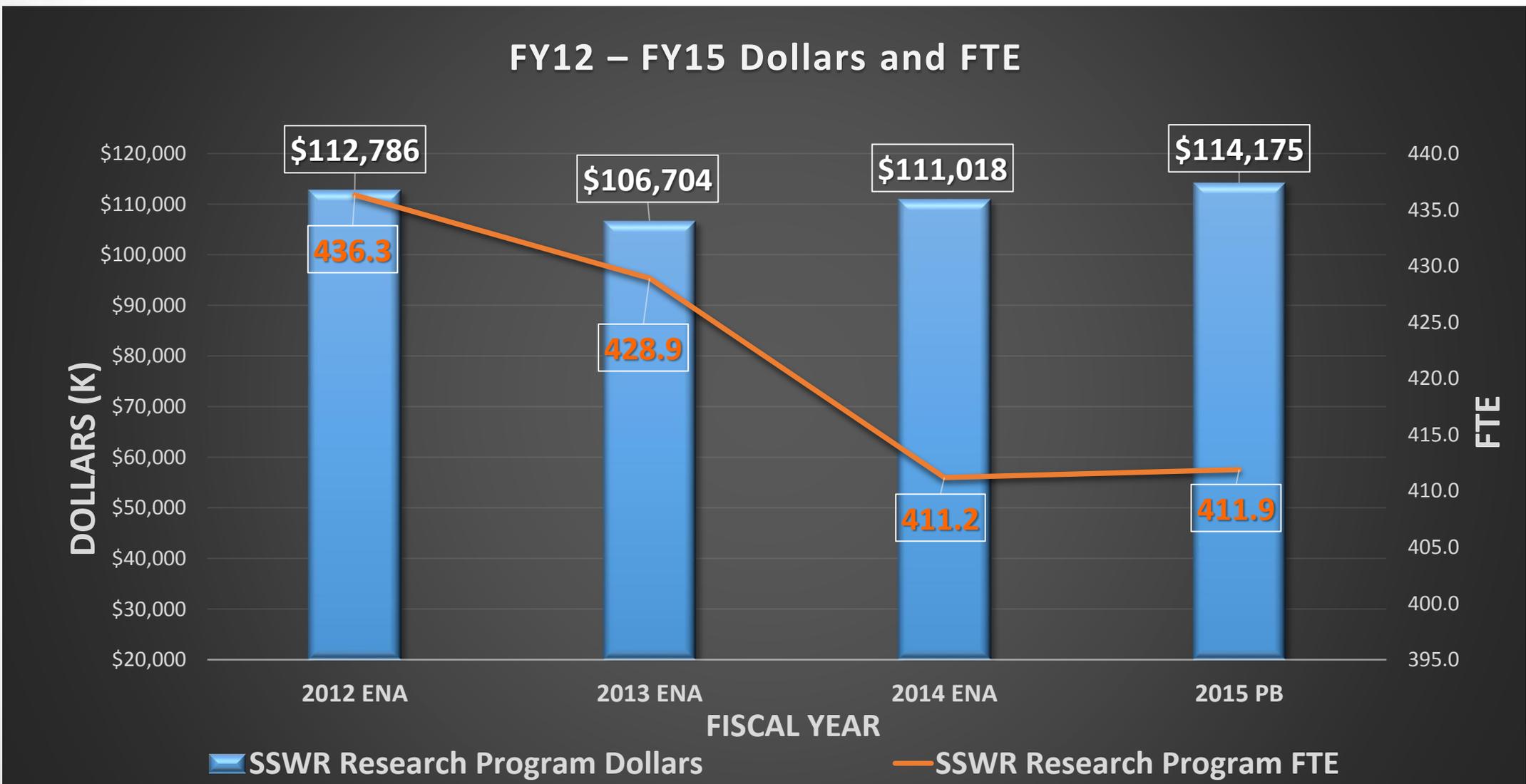
## Problem Statement

- ❖ Impairment and diminished availability of surface water and groundwater are of concern for human and ecosystem health, economic prosperity and social well-being.
- ❖ The rate at which water bodies are newly listed for water quality impairment exceeds the pace at which restored waters are removed from the list.
- ❖ Wetlands continue to decline.
- ❖ To restore and expand the Nation's deteriorating, buried drinking water pipes will cost more than \$1.7 trillion by 2050.
- ❖ Small public water systems face even greater technical, financial and operational challenges to develop and maintain the capacity to comply with new and existing standards.
- ❖ Limited knowledge exists of how changes in water quality can be valued.
- ❖ Overarching stressors: climate, extreme events, energy, agriculture, population growth, accidents.





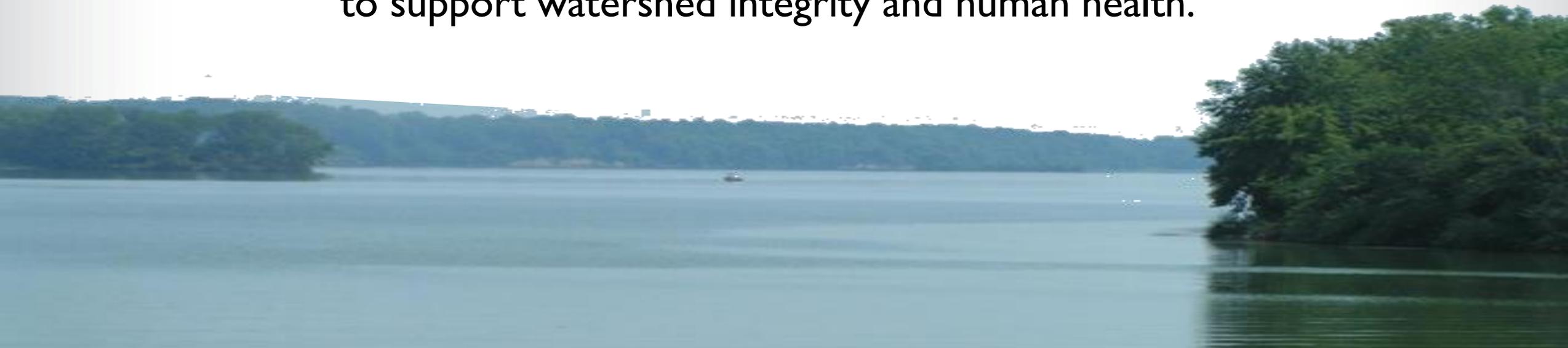
# SSWR Resource Trends





## SSWR Vision

SSWR will use an integrated, systems approach to purpose-driven, state-of-the-art research to support innovative scientific, technological and behavioral solutions that ensure clean, adequate, and equitable supplies of water to support watershed integrity and human health.





## SSWR Overarching Priorities

- ❖ **Current and long-term** water resource challenges for **complex chemical and microbial** pollutants to inform EPA's regulatory and non-regulatory decisions and its implementation needs.
- ❖ Watershed approach to protecting ecosystem and human health recognizing a dynamic **'one water'** hydrologic cycle (groundwater, surface water, drinking water, wastewater, stormwater, recreational waters).
- ❖ **Transform** the concept of **'waste' to 'resource'** by recapturing and reusing commercially valuable waste stream constituents (e.g., nutrients, energy, metals).
- ❖ **Preparedness** for changing climate, extreme events, land use (energy, agriculture). and population.
- ❖ Integrated throughout the program are the goals of a **sustainable environment, economy and society**.
- ❖ Translating research findings to **real-world solutions** that support communities, states, and tribal partners.





# SSWR Research Topics and Objectives

**Sustainability:** Environmental, Social (human health, EJ) and Economics

**Stressors:** climate change and extreme events (e.g., flooding, hurricanes, tornadoes, earthquakes, heat waves, drought, wildfire), land use (e.g., energy, mining, and agriculture), aging infrastructure, population growth



**Watershed Sustainability**

- Assess, Map and Predict the Integrity, Resilience and Restoration Potential of the Nation’s Water Resources
- Assess Life-Cycle Impacts of the Water-Energy-Mineral-Materials Nexus
- Integrate Watershed Management for Sustainable Outcomes

**National assessment of watershed sustainability using indicators of ecological condition and economic and social benefits**

**Nutrients**

- Thresholds & Targets for Appropriate Nutrient Levels
- Cost-effective Management Tools & Practices
- Metrics of Benefits, Accountability and Communication)

**Assess ecosystem, economic and social benefits of management actions for sustainable nutrient loading**

**Green Infrastructure**

Support Increased Adoption of GI into Community Stormwater Management Plans

- Models, Tools & Guidance
- Community Partnerships

**Develop and demonstrate tools to assess effectiveness and benefits for managing water volume and improving water quality**

**Water Systems (\*Small Systems)**

- Develop, Evaluate and Facilitate Adoption of Technologies to Support and Transform Water Systems
- Safety of Nation’s Water: health and environmental impacts of known/emerging, individual/groups/ of chemical/biological contaminants

**Transformative Systems: Integrated sustainability assessments, novel approaches and prioritized risks to provide a framework for decision making for alternative approaches to water systems to meet goals of public health protection and energy efficient resource recovery and reuse**



# Future Directions: Watershed Sustainability

## Research Objective 1:

### Assess, Map & Predict the Integrity, Resilience & Restoration Potential of Water Resources

- Assess, Map and Predict the Integrity, Resilience and Restoration Potential of Water Resource
- Current and predictive models that build on data from diagnostic tools, NARS, targeted watershed studies, land use, infrastructure)
- Utilize large volumes of environmental data, GIS, and modern computing power to assess, map, and predict watershed integrity (EnviroAtlas)
- Watershed degradation (tipping points), resilience and recovery
- Watershed connectivity
- Aquatic Life Criteria and Ambient Water Quality Criteria
- Invasive species tools for surveillance, prediction, risk assessment, and remediation
- NARS survey technical support: more rapid and cost-effective assessment methods and integrate ecological condition assessments with human health and economic dimensions
- Economic benefits of water quality

## Research Objective 2:

### Assess Life-Cycle Impacts of the Water-Energy-Mineral-Materials Nexus

- Proactively assess potential risks to groundwater and surface water from current, transitioning and emerging technologies/practices for the life cycle of conventional and unconventional energy, minerals, metals, and other materials
- Assess benefits and risks of using aquifers to store water for future use and to sequester polluted waters

## Research Objective 3:

### Integrate Watershed Management for Sustainable Outcomes

- Methods to foster sustainability: Accessible information, indicators, models, and other tools
- Integrated research to link community sustainability in SHC to management and sustainability at watershed scales in SSWR

*National assessment of watershed sustainability using indicators of ecological condition and economic and social benefits*

## Nitrogen and Co-Pollutant Roadmap

**Collaborative Effort:** ORD (SSWR, ACE, SHC), Office of Water, Office of Air and Radiation, EPA Regions

**Holistic Approach:** Cross-media (air, land and water), integrated, multi-disciplinary approach to sustainably manage reactive nitrogen (Nr) and co-pollutant (e.g., phosphorus, sulfur, sediments) loadings to reduce adverse impacts on the environment and human health.

**Goal:** Develop a common understanding of EPA's national research program portfolios to identify major focus areas, opportunities for integration and technological innovation, research gaps and future research directions.





## Future Directions: Nutrients

### Research Objective 1:

#### Thresholds & Targets for Appropriate Nutrient Levels

- Linking N and co-pollutant water quality impairments to quantitative loads; improve prediction of how impairments vary with changes in load, concentration, and biogeochemical conditions
- Determine how magnitude, frequency and duration of loading affects different aquatic endpoints
- Develop and integrate ecosystem service metrics and accountability measures for social and economic endpoints that
- Support OW in deriving aquatic life criteria and downstream protection for N and P
- Harmful algal blooms: relationship of water temperature, duration and cyanotoxin production

### Research Objective 2:

#### Cost-Effective Management Tools & Practices

- Tools to assess effectiveness of management actions
- Tools to determine nutrient source apportionment in watersheds
- New technological applications (genomic indicators of sources/effects, satellite monitoring, sensors)
- Support and enhance monitoring programs for system-level, long-term responses to policies/management
- Predict, prevent, and remediate N and co-pollutant contamination of drinking water sources (surface and groundwater)

### Research Objective 3:

#### Metrics of Benefits, Accountability & Communication

- Communication tools
- Quantify N and co-pollutant reductions to ecosystem and human health benefits
- Socioeconomic metrics
- Accountability: model changes in biological response/biodiversity and social and economic endpoints

*Assess ecosystem, economic and social benefits of management actions for sustainable nutrient loading*



# Future Directions: Green Infrastructure and Stormwater

Support Increased Adoption of GI into Community Stormwater Management Plans & Watershed Sustainability Goals:

## Research Objective 1:

### Advancement of Green Infrastructure Models & Tools

- Models, Tools & Guidance - development/adaptation and assessment
- Increase accessibility of existing stormwater modeling tools to the user community

## Research Objective 2:

### Information & Guidance through Community Partnerships

- Pilot studies on effectiveness of GI and potential co-benefits
- Linkages between GI and infiltration, groundwater recharge, and aquifer storage and recovery
- Impacts of excess nutrients on constructed wetlands

*Develop and demonstrate tools to assess effectiveness and benefits for managing water volume and improving water quality*



## Future Directions: **Water Systems**

### **Research Objective 1:**

**Develop, Evaluate and Facilitate Adoption of Technologies to Support and Transform Water Systems**

### **Research Objective 2:**

**Safety of Nation's Water: health and environmental impacts of known/emerging, individual/groups/ of chemical/biological contaminants**

*Transformative Systems: Integrated sustainability assessments, novel approaches and prioritized risks to provide a framework for decision making for alternative approaches to water systems to meet goals of public health protection and energy efficient resource recovery and reuse*



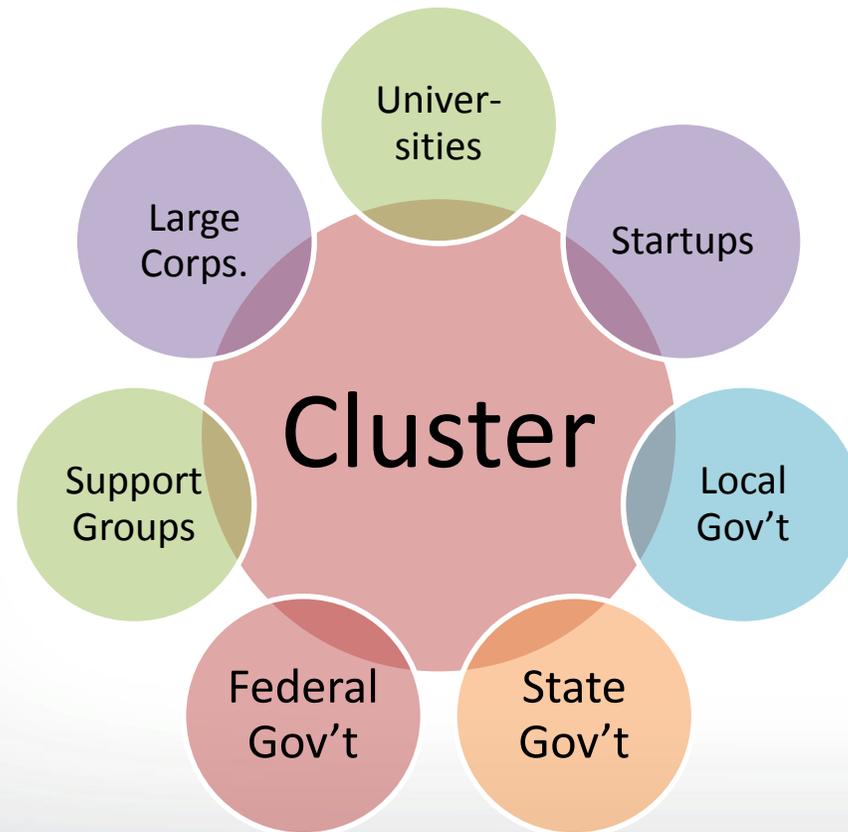
## Future Directions: Water Systems

**Cross-cutting challenges for sustainable, cost-effective, low C footprint water treatment innovations to safeguard human health and the environment from known and emerging, chemical and biological contaminants (groups, mixtures) in water resources (drinking water/sources, treated wastewater, recreational waters).**

- Small Systems
  - Financial, infrastructure and human resource/technical expertise limitations
  - Small scale research translated to larger systems (centralized small, clustered decentralized)
- Reuse and Recovery
  - Direct and indirect potable water reuse and expanded use of non-traditional waters
  - Risk assessment and mitigation approaches Fit-for-Purpose options
  - Recovery of nutrients, energy, metals, and chemicals
- Resilience ‘prepare for and adapt to changing conditions, and withstand and recover rapidly from disruption’
  - Protect water quality and availability
  - Protect capital investments and minimize reconstruction costs
- Non-technological, Societal Factors
  - Public acceptance/community outreach
  - Financing and business development

## Innovation through Partnerships

Technology innovation clusters are **dense, regional networks** of companies and other groups with a **specific industry focus**.



### Cluster organizations fast-track innovation by

- Connecting researchers, business partners, and end users to facilitate the transfer of new technologies to the market.
- Engaging communities around technology challenges
- Leveraging diverse assets that reside in local communities to create economic opportunity and catalyze innovation.



## More Partnerships

### Department of Defense / Army

- Advancing sustainability, security, and resiliency
- Include technology demonstrations, social science study, and life cycle analyses
- Exemplifies cross agency (EPA, DOD, DOE, USACE, USGS) and multi-sector (KSU, NGOs, private industry) collaboration to leverage resources and expertise

### Current Projects:

- Decentralized Wastewater Reuse
- Water Quality at LEED Hospital
- Outreach Study
- Joint ESTCP Solicitation

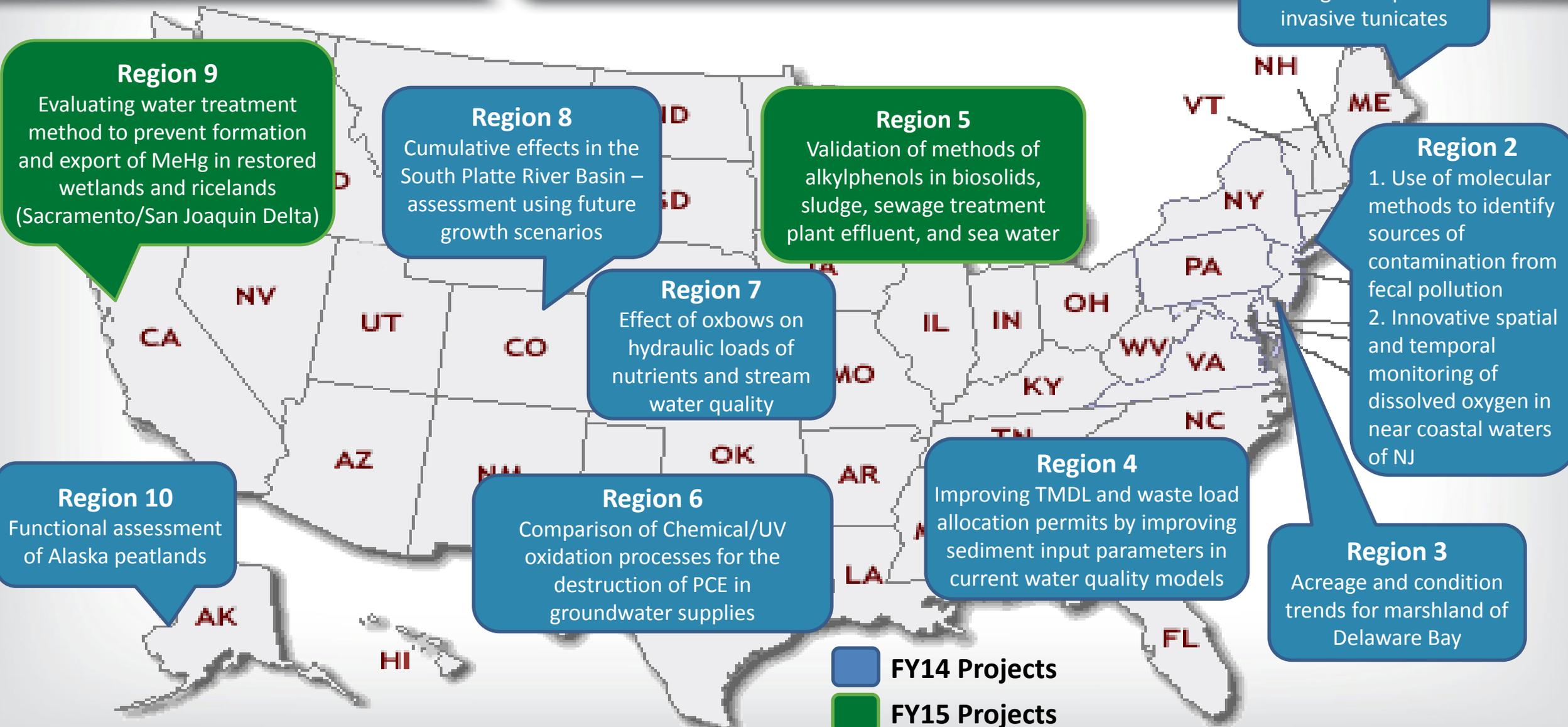


### **NCER/STAR: *Human and Ecological Health Impacts Associated with Water Reuse and Conservation Practices***

Research and demonstration of human and ecological impacts of treated wastewater applications (reclaimed water and wastewater reuse), and water conservation practices (including the use of non-traditional water sources) and more comprehensive long-term management and availability of water resources.



# SSWR Regional Research



FY14 Projects  
 FY15 Projects



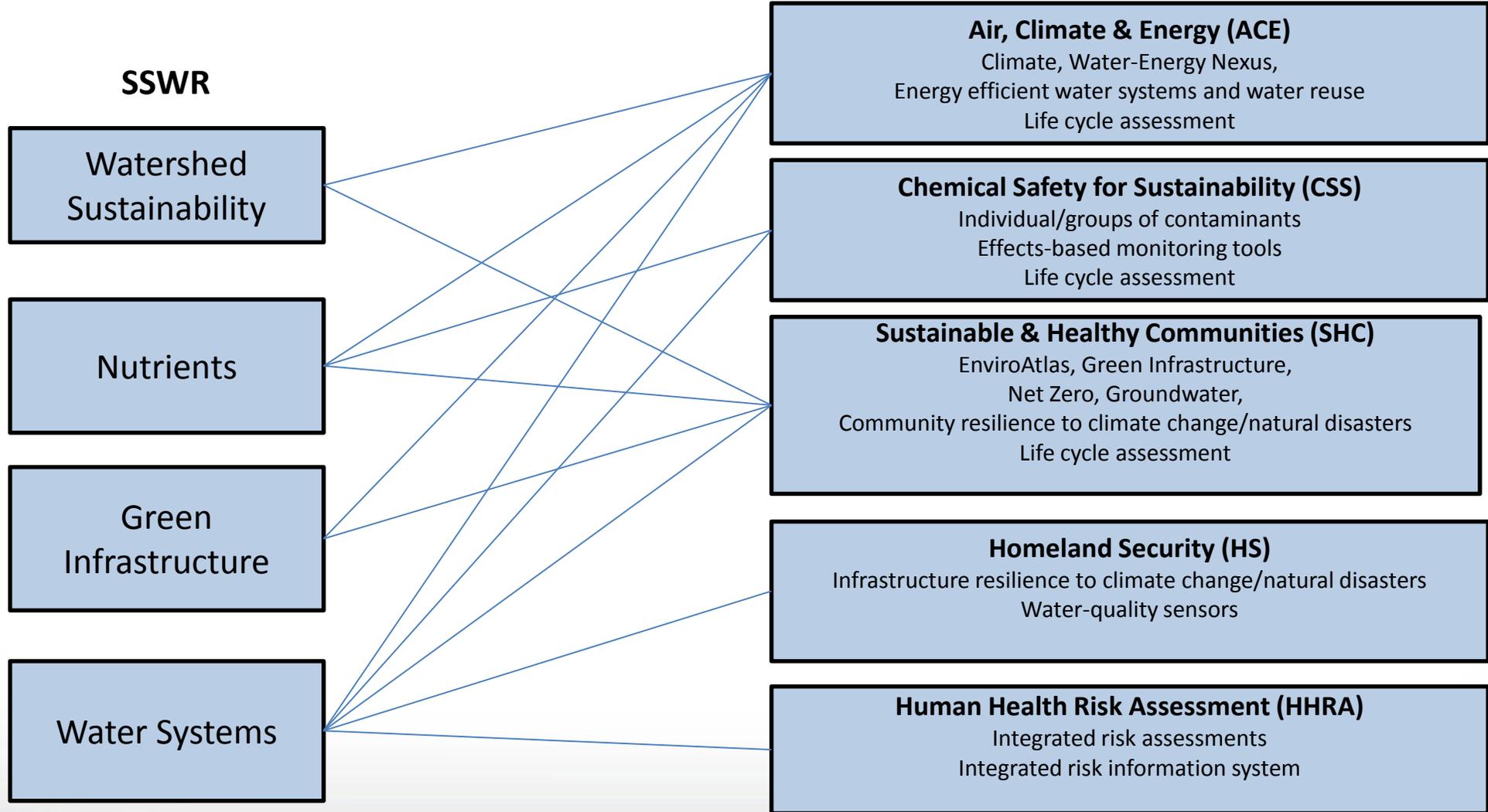
## Responsive Research for EPA Regions



- Investigate how drought may impact surface water and groundwater quality and availability
- Examine secondary drought-related events
- <http://epa.gov/ncer/rfa/2014/2014-star-natl-priorities.html>



# ORD National Program Integration





# Roadmaps for Cross-Cutting Issues

## Research Roadmaps

- **Nitrogen and Co-Pollutants**
- Global Climate Change
- Children's Environmental Health
- Environmental Justice

## Purposes

- Describe coordination/collaboration with EPA and federal partners, others
- Show how research is integrated across the six programs; identifies gaps
- Catalyze integration across the six programs
- Focused on a small number of cross-cutting issues

## Key Distinction from StRAPs

- Not creating additional research programs
- Does not serve as basis for resource planning
- Informed by and informs the StRAPs

SAB BOSC Meeting  
July 25, 2014  
Program Integration Road Maps

### ORD Presenter

- Dr. Walt Nelson

### SAB and BOSC Members Lead Discussants

- Dr. Kenneth Reckhow
- Dr. David Dzombak





# Leading Science and Innovation

## NCER and its Science to Achieve Results (STAR)

*SSWR funds RfAs on emerging and anticipatory water resource challenges that take advantage of external social and economic expertise to translate science in support of communities.*

- GI Stormwater Management Approaches at the Urban Watershed Level – Philadelphia
- Human and Ecological Health Impacts Associated with Water Reuse and Conservation
- Center for Water Research on a Systems View of Nutrient Management
- National Center for Innovation in Small Drinking Water Systems
- National Center for Sustainable Water Infrastructure Modeling Research

## Small Business Innovation Research Program

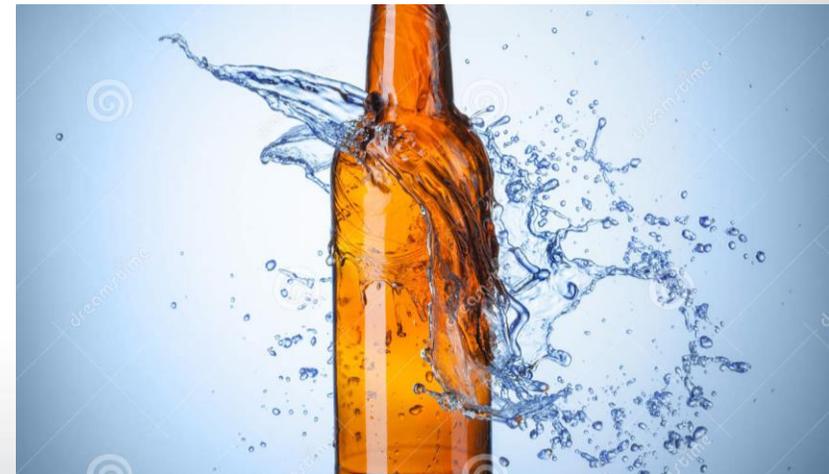
*Example - Cambrian Innovation's EcoVolt system enables the food and beverage industry to cut water and energy costs by simultaneously treating wastewater and generating energy on site.*

## Pathfinder Innovation Program

*Example - Next generation environmental barcoding: Assessing diversity in a complex system*

## Regional and Applied Research Efforts/Methods (RARE/RM)

*Examples – R1, R2, R6 Rain garden capacity demonstration project, quantifying the quantity and quality of runoff from urban green roofs, and microorganisms associated with rainwater collection systems providing non-potable or potable water*





## Real Solutions for Real-World Water Challenges

### **Watershed Sustainability: Bayesian decision support system for sediment transport in coastal systems**

- Highly manipulated watershed in Puerto Rico - five reservoirs and an extensive tunnel and canal system constructed dramatically altered the natural hydrology of the region and exacerbated sediment delivery to sensitive coral reef ecosystems.
- Illustrates a Bayesian probability network for linking sediment transport in the watershed to sediment effects on the coastal resources.
- A systems perspective facilitates comparison of tradeoffs among decisions proposed to support land use demands, water use demands, and the integrity of aquatic ecosystems.
- An interagency initiative to protect coral reefs has led to multiple management proposals that will affect existing and future land and water uses.

### **Nutrients: Center for a Systems View of Nutrient Management**

STAR grants for nutrient management demonstration projects that include behavioral, technological, and economic considerations of management options, and evaluation, acceptance and implementation of options.





# Real Solutions for Real-World Water Challenges

**National Stormwater Calculator**

Overview | Location | Soil Group | Conductivity | Slope | Rainfall | Evaporation | Land Cover | LID Controls | Runoff Results

Site Name (Optional)  
AWBERC

Search for an address or zip code:  
26 West MLK Dr., Cincinnati, OH

Site Location (Latitude, Longitude)  
39.13684969226269,-84.5113542079925

Site Area (acres - Optional)  
20

[Open a previously saved site](#)

Use the navigation tools on the map to locate the site to be analyzed and then click on its location. You can also locate the site by providing its address or zip code.

Locate the site on the map.

**National Stormwater Calculator**

Overview | Location | Soil Group | Conductivity | Slope | Rainfall | Evaporation | Land Cover | LID Controls | Runoff Results

**Analysis Options**

Years to Analyze: 10

Event Threshold (inches): 0.10

Ignore Consecutive Days:

[Compute Runoff](#)

[Use as Baseline Scenario](#)

[Remove Baseline Scenario](#)

[Print Results to PDF File](#)

[Analyze Another Site](#)

Site Description | Summary Results | Rainfall Percentiles | Rainfall/Runoff | Runoff

Statistic	Current Scenario	Baseline Scenario
<b>Annual Averages</b>		
Average Annual Rainfall (inches)	43.60	43.60
Average Annual Runoff (inches)	4.13	25.90
Days per Year with Rainfall	78.46	78.36
Days per Year with Runoff	8.90	54.57
<b>Daily Rainfall Statistics</b>		
Percent of All Rainfall Retained	91.28	42.26
Percent of Wet Days Retained	88.66	30.36
Smallest Rainfall w/ Runoff (inches)	0.42	0.12
Largest Rainfall w/o Runoff (inches)	1.50	0.30
Max. Retention Volume (inches)	2.10	0.78

This table displays the average annual rainfall and runoff for the site. It also lists several overall measures that summarize how well the site retains daily rainfall events.

Runoff results are up to date.

## Stormwater Calculator with Climate Scenarios

- Estimates site-scale stormwater runoff with GI/Low Impact Development options to reduce runoff and maintain or restore more natural hydrology
- Historical weather data and future climate scenarios (monthly, 24 hour)
- Example users: building developers, landscape architects, community planners, policy makers
- 39,812 page views; 13,000+ downloads
- Promo video viewed >9,000 times and won a TELLY award
- Demonstration for Congress Fall 2014

## National Center for Sustainable Water Infrastructure Modeling Research - Cooperative Agreement with ORD

Supports communities by increasing accessibility and use of EPA tools

1. Novel Research towards improving real time control, advancing software design, building next generation of water modeling tools
2. Community Support and Outreach that fosters and trains a community of modelers, model users, and stakeholders
3. Model and Code Development of freely available software models of sustainable stormwater, wastewater, and water supply systems



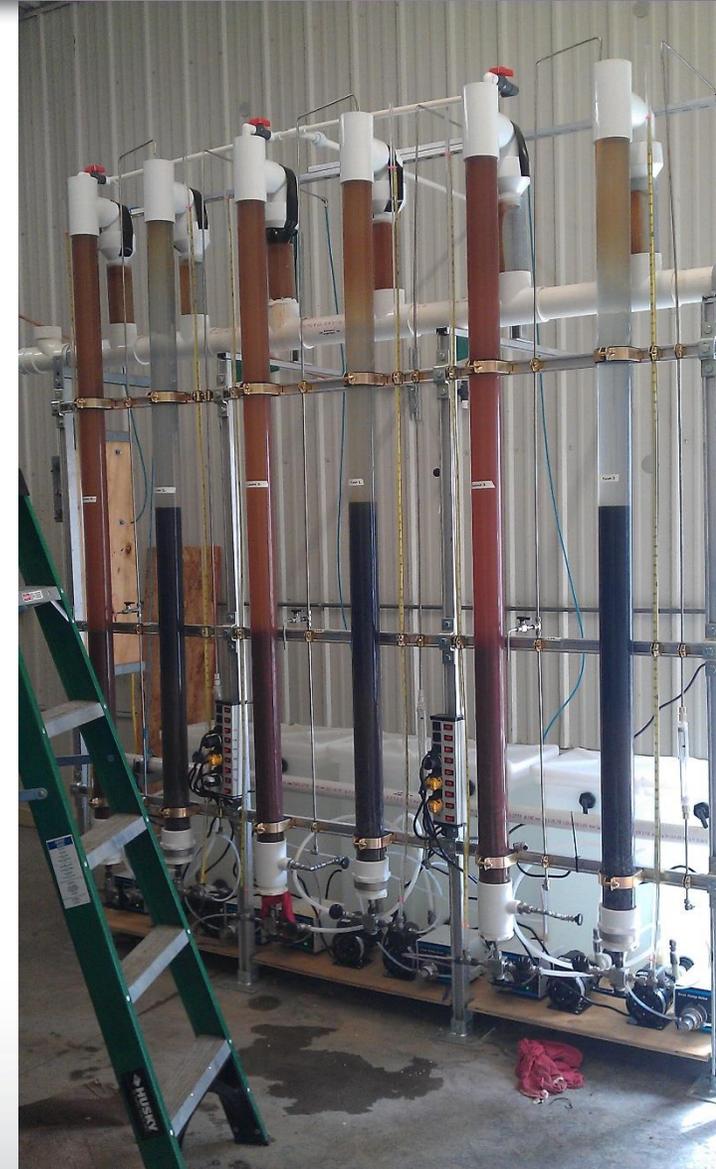
## Real Solutions for Real-World Water Challenges

### **Innovative Biological Treatment Process for the Removal of Ammonia from a Small Drinking Water System**

- Palo, IA (population 980) relied on individual and neighborhood shallow wells, which became contaminated after the flood in 2008.
- EPA ORD and Region 7 and State of Iowa DNR conducted a pilot study using an EPA developed and patented biological water treatment technology for ammonia oxidation. The pilot system was designed, built, and installed by EPA staff and has demonstrated the ability to effectively remove ammonia and iron from the community's source water, while keeping nitrite and nitrate levels below their respective maximum contaminant level in the treated water.
- As part of a federal HUD grant, the full-scale water treatment plant based on the pilot system was completed in Jan. 2014.

### **Annual Small Systems Workshop**

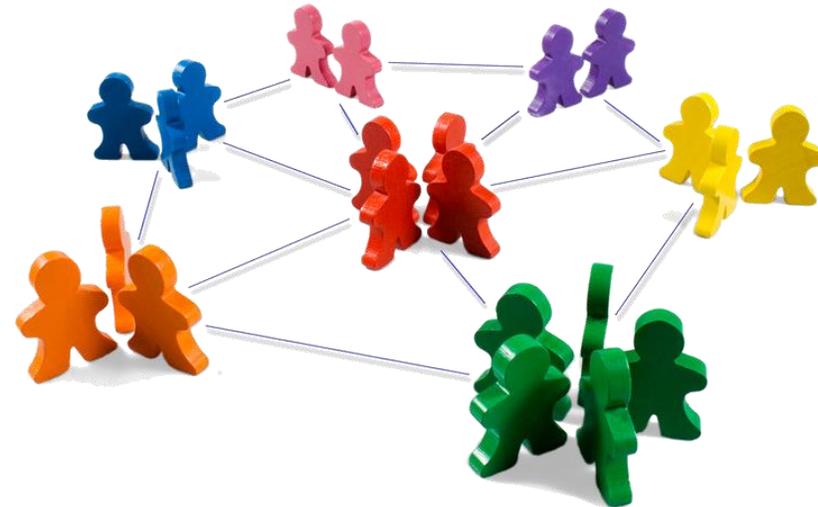
- Open to public for in-depth training and information on various solutions and strategies problems and compliance challenges
- ~250 registered attendees from 40+ states, U.S. Island Territories, and international
- Workshop products from communication workgroups





# Translating and Communicating Science

- **Monthly Public Webinars**
- **Science Matters Newsletter**
- **It All Starts with Science Blog**
  - 9,332 page views,
  - 34 blog posts in 2013, 48 comments
- **Social Media**
  - Twitter chats with OW
- **Water Research Update**
  - Sent quarterly
  - 5,000 subscribers





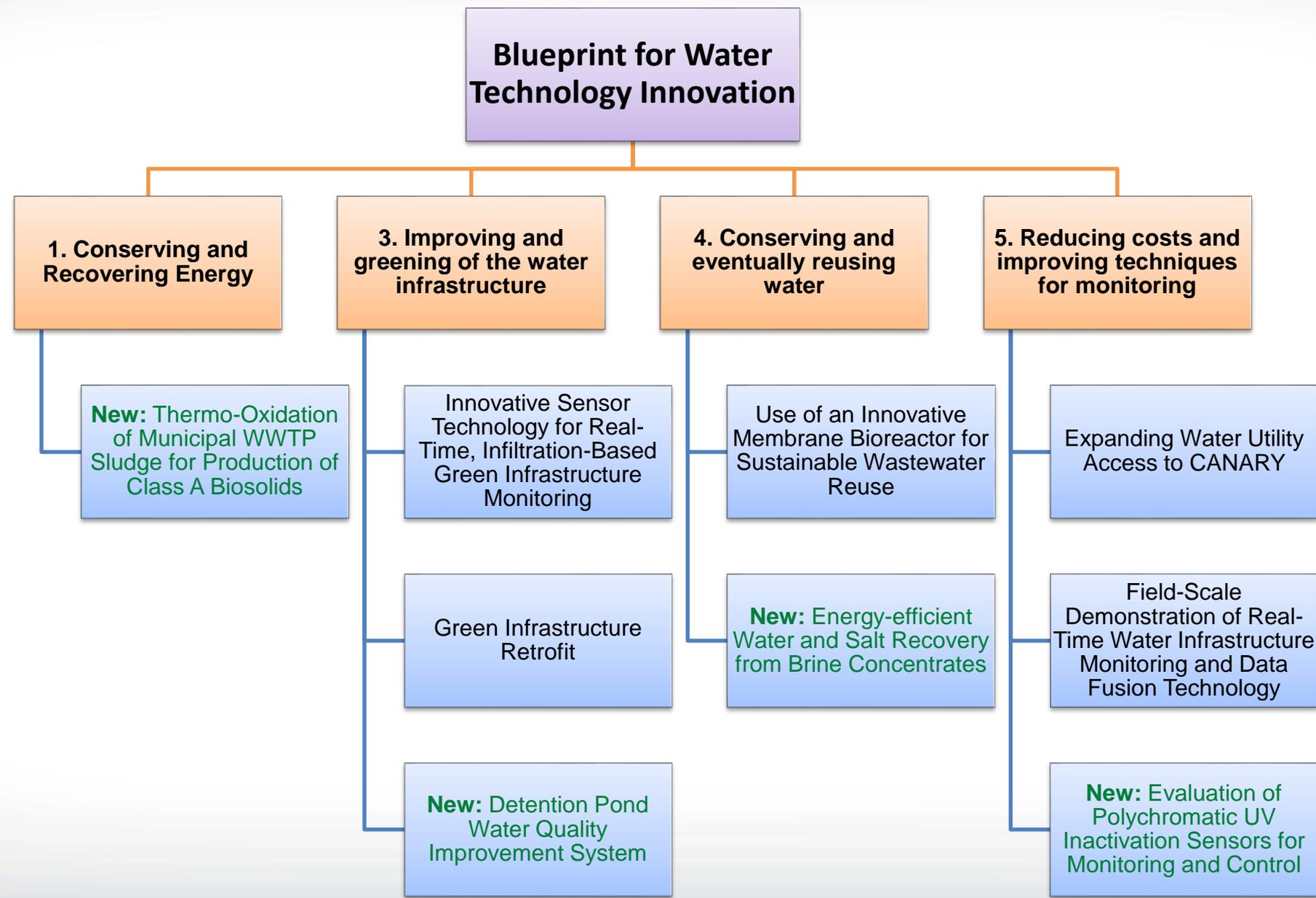
# Discussion





# Appendix

# Mapping Water Cluster Projects to OW Blueprint Priorities



# Mapping Water Cluster Projects to OW Blueprint Priorities

