



# Overview of Water Reuse Challenges and Opportunities

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**STAR Grant Kickoff Meeting  
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# About Water Environment & Research Foundation

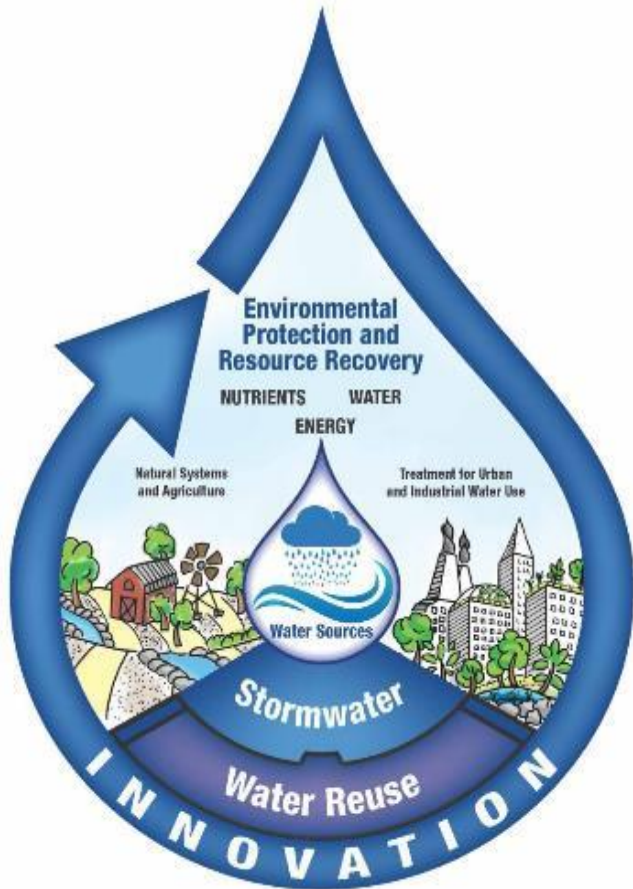
WERF and WRRF merged in May 2016

*WE&RF: Dedicated to research on renewable resources from wastewater, recycled water, and stormwater while maintaining the quality and reliability of water for the environment and communities.*

***New Focus: One Water.***

**WaterReuse** brings recycled water, desalination and related topics.

**WERF** brings wastewater, resource recovery, stormwater, receiving waters, climate change, and integrated water.



# About WE&RF

501(c)(3) nonprofit located in Alexandria, VA

## 1989-2016: Research portfolio

- >\$200 million on water, wastewater, recycled water, and stormwater

## Research organization

- >400 subscribers
- Partners: U.S. EPA, DOE, Bureau of Reclamation, CA State Water Board, other states
- 30 staff members (over half manage research)
- Broad focus on integrated water research

## Research Programs

- Solicited
- Unsolicited
- Tailored Collaboration and Subscriber Priority Programs
- Partnership Program





# Bottom Line: Major Paradigm Shift

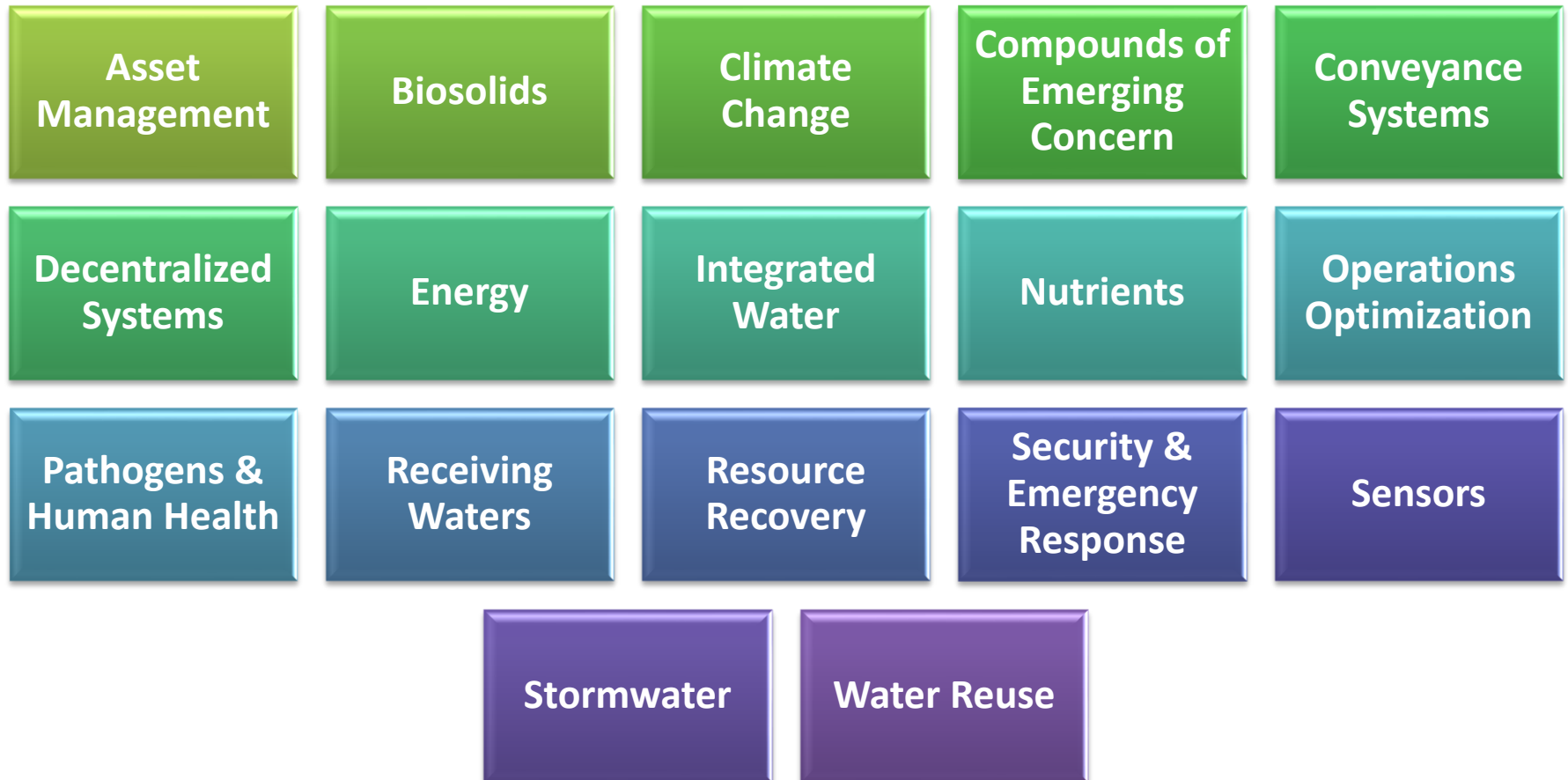
## PAST

Collect wastewater, move it quickly downstream, treat it to acceptable standards, and dispose of waste without harming the environment

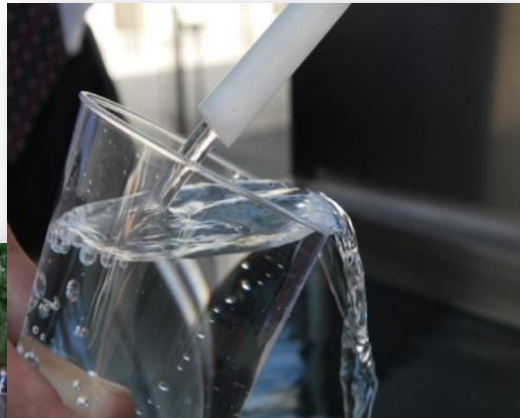
## FUTURE

- Manage resources to generate value for the utility and its customers
- Improve environmental quality, at least cost to the community
- Use a holistic “one water” approach to water management

# Areas of Research



# The Full Spectrum



Urban Irrigation

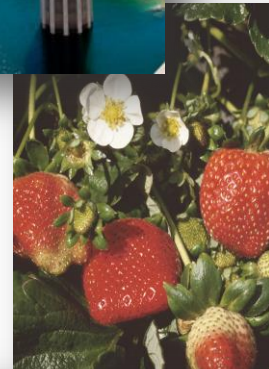
Industrial Reuse



Potable Reuse

Food Crop Irrigation

Wetland/  
Habitat  
Restoration



# Fit for Purpose

## The right water for the right use

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### Agricultural Reuse

Great potential for enhanced utilization of recycled water



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Ongoing research: WRRF-15-08 - State of Irrigated Agricultural Water Reuse - Impediments and Incentives

Upcoming research to identify existing uses, characterize potential, and develop strategies for overcoming barriers and incentivizing greater use of recycled water

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Will evaluate existing governance frameworks and develop recommendations

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New research: Evaluating Economic and Environmental Benefits of Water Reuse for Agriculture



# Fit for Purpose

## The right water for the right use

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### Industrial Reuse

Private businesses and government have different mandates and priorities

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Different industrial sectors have different needs for water quality and quantity

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Completed research seeks to bridge the gap between business and government as well as identify the similarities and differences between sector and end-use

WRRF-13-04 - Drivers, Successes, Challenges, and Opportunities of Onsite Industrial Water Reuse: a Path Forward for Collaboration and Growth

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Ongoing research to develop a framework for onsite reuse and a decision support tool for evaluating the economics of potential projects

WRRF-14-04: A Framework for the Successful Implementation of Onsite Industrial Water Reuse

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# Potable Reuse

**Drivers**

- Drought
- Increased Demand
- Lack of or contaminated local supply

**Potable Reuse is**

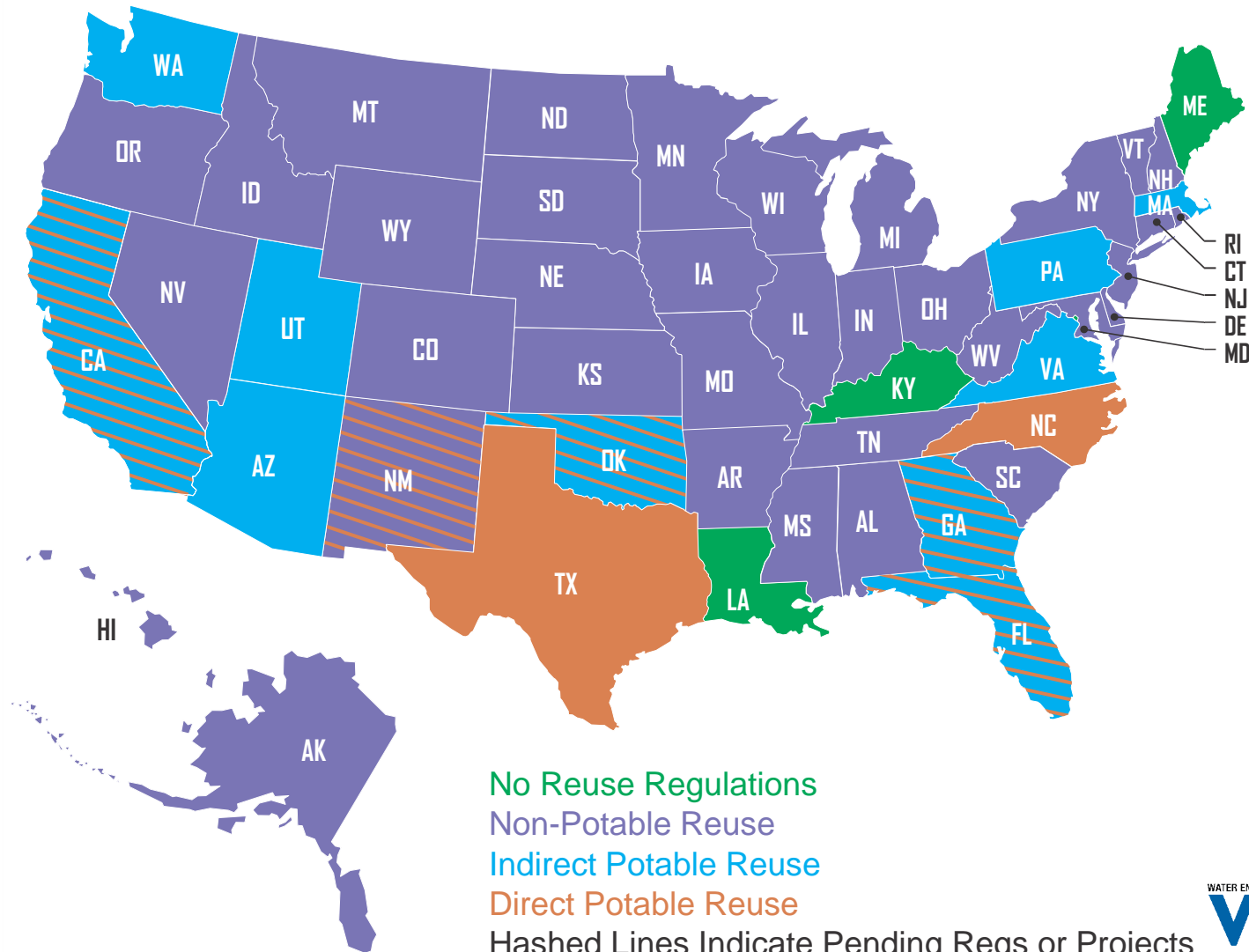
- Safe
- Reliable
- Locally-Controlled
- Environmentally-Friendly

**Tools to deliver**

- Research
- Technology
- Sound Science
- Innovation



# The “State” of Reuse: Developing Consensus on Public Health Protection





# DPR: The Key Questions

- **Treatment requirements**
  - Need for criteria for pathogen and chemical control
- **On-line monitoring**
  - Performance monitoring
- **Treatment technologies**
  - Defining reliability
- **Source control**
  - Managing the collection system
- **Operations and operators**
- **Response time** (respond to off-spec water)
- **Public acceptance**

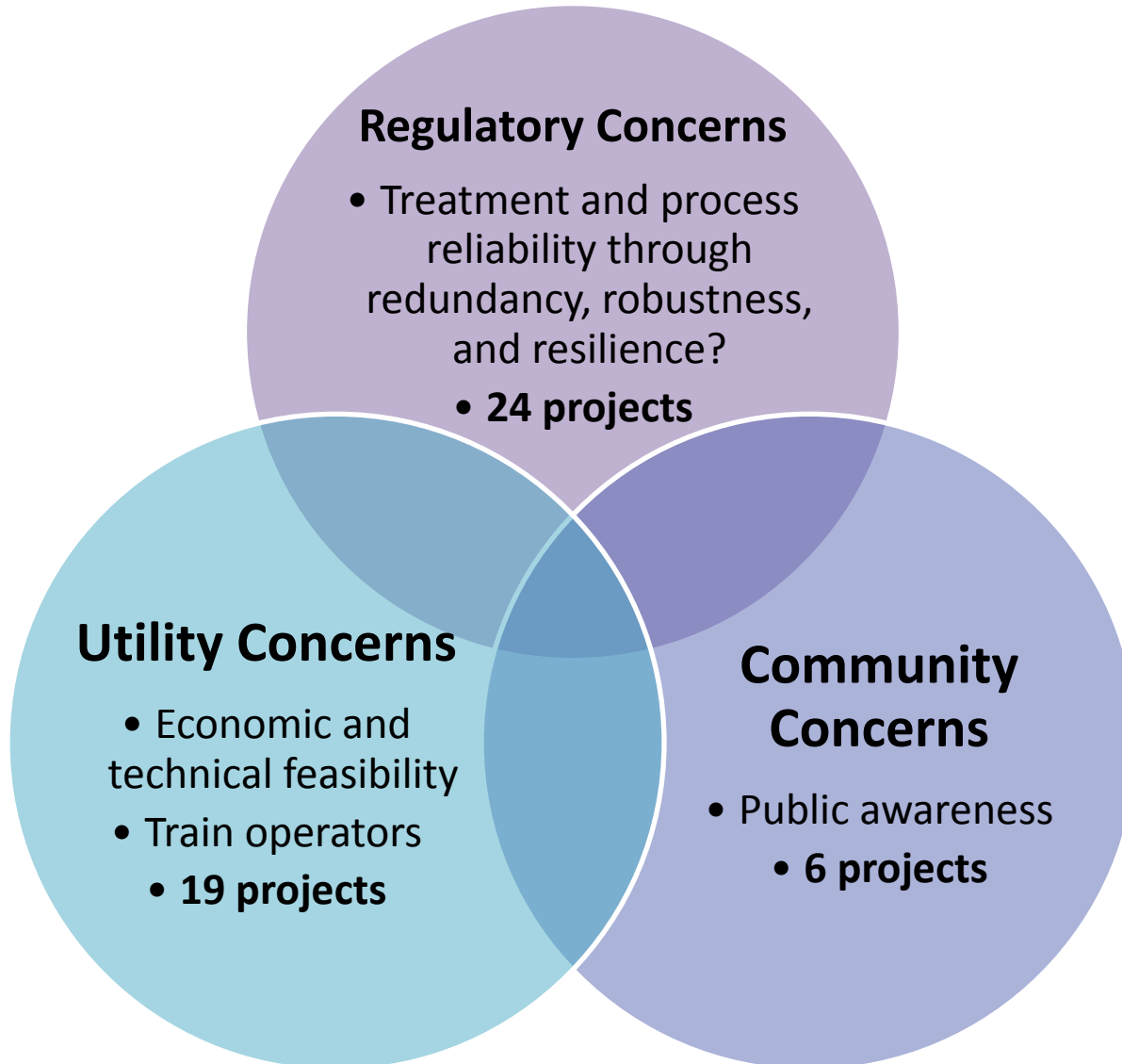
# WaterReuse DPR Research Initiative

- ❖ California: “Feasibility of developing criteria for DPR”
- ❖ \$6M raised to the need to fill knowledge gaps – leveraged to \$24M
- ❖ Funded 34 projects on topics
  - Reliability of treatment trains
  - Microbial and chemical water quality
  - Monitoring
  - Operations

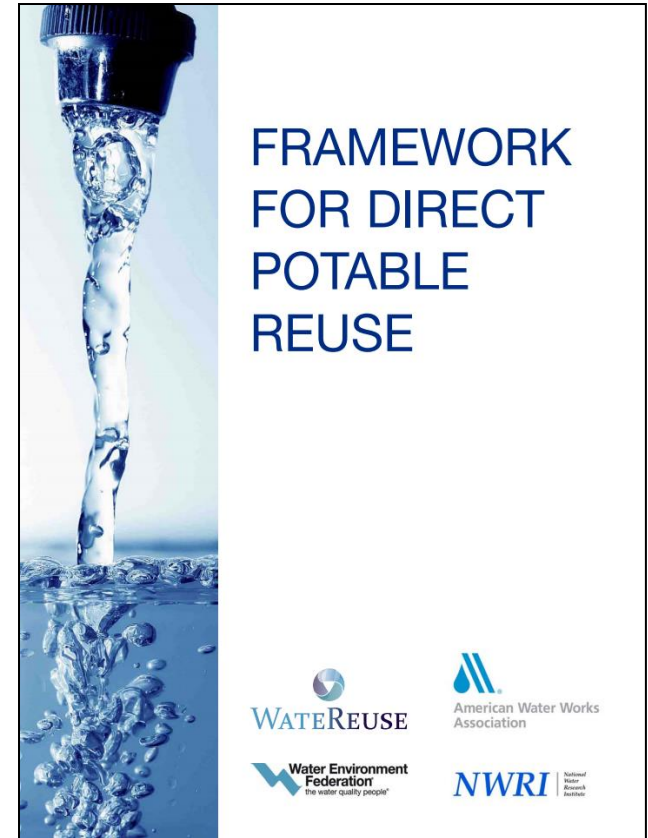
“The Expert Panel is impressed by the research that has been funded by the WRRF and supports the continuation of such research.”

- June 30 letter to DDW from Expert Panel Chairs

# DPR Initiative Research



# Project: Framework for DPR



Purpose: To provide an overview of the key elements that make up a DPR program.

# Coming Soon!

## Potable Reuse Research Compilation: Synthesis of Findings (15-01)

This project summarizes and synthesizes the research results, pulling from outside research where needed, and package this information by topic into a cohesive document.

### WATER REUSE Direct Potable Reuse Research: Synthesis of Findings

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#### INTRODUCTION AND OBJECTIVE

- In response to stressed water supplies in some regions of the United States, some communities are looking toward direct potable reuse (DPR), where treated wastewater is used to augment potable water supplies. As interest in potable reuse has grown, so has the need for providing guidance for DPR. To improve the California regulatory process, the Expert Panel is scheduled to produce a draft report on the Feasibility of Developing Standards for DPR based on a review by an Expert Panel.
- To inform the panel, the WaterReuse Research Foundation launched the DPR Research Initiative in 2012 to advance DPR as a water supply option. This effort includes 34 research projects to value at over \$20 million.
- The Expert Panel is scheduled to produce a draft report on the Feasibility of Developing Criteria for Direct Potable Reuse in 2016. To fulfill its charge and finish the report, the Panel will need the most up-to-date information on current research and activities pertaining to DPR in the United States.

#### TOPICS ADDRESSED

UTILITY CONCERNS  
19 projects

REGULATORY CONCERNS  
23 projects

COMMUNITY CONCERNS  
6 projects

#### KEY ISSUES | FINDINGS BY TOPIC

##### SOURCE CONTROL PROGRAM

- Identify nonpoint sources, businesses, and industry
- Minimize sources of toxic compounds entering the sewerbody
- Evaluate contaminant sources susceptible through infiltration as part of the existing wastewater treatment program
- Contaminants found in source waters often times do not or cannot pass through all of industrial sources, such as lead, zinc, metals, NDMAs, bromates, and disinfection byproducts

##### MONITORING OF PATHOGENS

- Rapid and continuous monitoring for pathogen detection remains challenging due to small water flow size, without sensitivity and the low concentrations of pathogens.
- Limited options available for rapid online pathogen monitoring with several technologies in the developmental stage.
- DPR may be detecting changes in water due to the lack of sensitive technology, limiting the credits awarded to maintain low risk.
- Local systems need multiple high specificity, high-sensitivity online capability, high sensitivity accuracy, and robustness with low false rates along with reliability and affordability for operation and maintenance.

##### OPERATIONS AND MAINTENANCE

- Early operations activities include startup testing, commissioning, operation training, and final acceptance.
- Requirements for operations plans with action and response procedures are needed to support facility resiliency.
- Standards for maintenance plans that preserve and manage performance of industrial, equipment, and monitoring are lacking.
- Knowledge gaps exist in operation training and certification programs that specifically address wastewater, water treatment, and water distribution rather than using a combined approach.

##### POTENTIAL DPR TREATMENT TRAINS

- Determine DPR treatment trains based on the following:
- Characterization of source water including variations in flow and load.
  - Evaluation of design and operation of the WWTP including conditions that can degrade treatment quality for advanced treatment.
  - Identification of water quality goals and aesthetic requirements.
  - Identification of multiple treatment barriers for pathogens and organics to meet regulatory barriers and water quality goals.
  - Determine the reliability and redundancy metrics for treatment process, including the ability to address WWTP upsets.
  - Determine required system redundancy based on WWTP effluent compared to site water production goals.
  - Identify water disposal constraints in disposing of high salinity waste.
  - Determine of space constraints for the construction of treatment trains.
  - Estimate capital and operating costs.

##### CHEMICALS

- Occurrence**
- Concentrations of Emerging Chemicals (CECs) are present in secondary and tertiary treated effluent streams.
  - New CECs are expected to be found in the future.
- Treatment**
- Different treatment processes have different efficacies in removing CECs.
  - Advanced water treatment does an excellent job removing the majority of known CECs to below detection limits.
- Risk**
- The risks associated with CECs likely come from very low concentrations.
  - Persistence of the risks associated with CECs is greater than the actual risk.

##### FAILURE AND RESILIENCY

- The application of "holistic" principles to engineered processes is a relatively new endeavor.
- The two required forms of resilience are (1) resiliency of and (2) adaptability to disturbances or failures.
- With respect to public needs, the two main components of failure response are: (1) failure detection and (2) failure mitigation.

##### PATHOGENS

- Improved understanding of pathogen treatment can be made in the following areas:
- Methods to rapidly determine the concentration of pathogens or identify surrogates.
  - Greater understanding of pathogen levels in untreated wastewater and their removal through advanced treatment processes.
  - Improved methods to verify pathogen inactivation and/or removal for base-line accuracy (removal rates of bacteriophage cocktails).
  - Improved understanding of the impact of finished water on the persistence of opportunistic pathogens in drinking water distribution systems.

##### MONITORING DPR SYSTEMS AND THE CRITICAL CONTROL POINT APPROACH

- The transition from indirect potable reuse (IPR) to DPR results in an increased response time to disruptions in water quality.
- The critical control point (CCP) approach is a systematic way to anticipate and respond to human health through monitoring and control strategies related to physical locations within the treatment process. The CCP approach focuses on the monitoring and control of treatment processes for acute health risks and operational parameters.
- Monitoring strategies are now available for DPR, increasing confidence and providing opportunity for improved efficiency.

##### DEMONSTRATION OF RELIABLE REDUNDANT TREATMENT PERFORMANCE

- Production of high-quality advanced treated water can only be achieved through the coupling of reliable and redundant treatment processes.
- To achieve reliable performance, individual treatment processes must be selected that are known to target specific contaminants for removal.
- To achieve redundancy, the dual treatment system must call both multiple barriers for any given contaminant.
- A barrier can be technical, operational, or managed and in nature.
- Verification of whether a barrier can be used to mitigate or reduce identified human health risks is of critical importance. The two main components of failure response are: (1) detection and (2) mitigation.

Contaminant	Barrier 1	Barrier 2	Barrier 3	Barrier 4	Barrier 5	Barrier 6	Barrier 7	Barrier 8	Barrier 9	Barrier 10
Microbial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Organic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inorganic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trace Organics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Heavy Metals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Disinfection Byproducts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Emerging Chemicals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

##### CONCLUSION, NEXT STEPS, AND ACKNOWLEDGEMENTS

- Initial draft of the synthesis report was provided to the Expert Panel in March 2016. The Expert Panel is using the initial draft to commission the research for developing their recommendations.
- Final synthesis report of all topics will be completed in August 2016.
- This information will be useful for utilities and regulators in the U.S. and abroad interested in implementing DPR as a source of water supply.

**ACKNOWLEDGEMENT** WaterReuse acknowledges the funding support of Singapore PWS, Utilities Board as well as the California State Water Resources Control Board under Contract No. 13-CO-0109 with the direction of the WWRP Project Managers, Steve Woggonen.





# WRRF 15-01 Topics

Demonstration of reliable, redundant treatment performance

Critical control points

Operations, maintenance, training/certification

Pathogens: surrogates and credits

Pathogens: rapid/continuous monitoring

Failure and resiliency

Removal and risk of constituents of emerging concern

Evaluation of potential DPR trains

Source control

# Recent CA Documents

- SWRCB Feasibility Report
- Expert Panel Report
- Advisory Group Report



Released on Sept 8, 2016:

[http://www.waterboards.ca.gov/drinking\\_water/certlic/drinkingwater/rw\\_dpr\\_criteria.shtml](http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/rw_dpr_criteria.shtml)

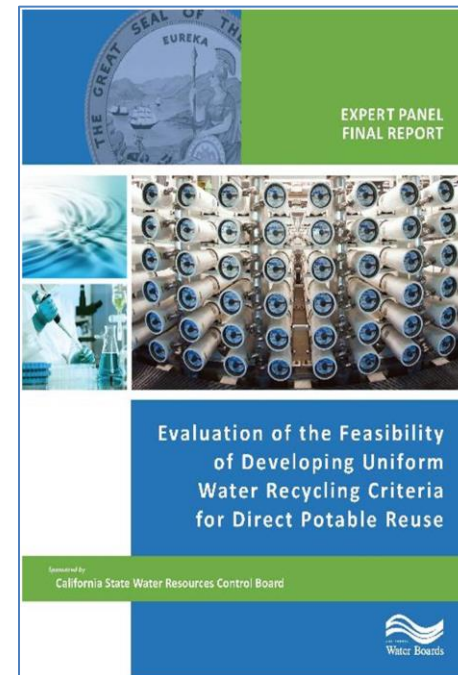
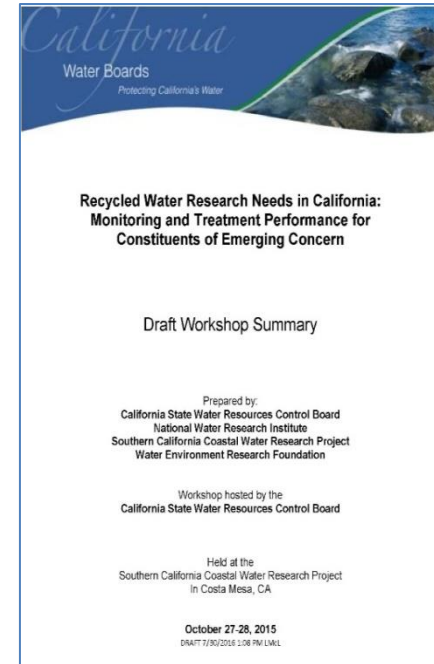
# Overall CA Expert Panel Finding

**It is feasible to develop uniform water recycling criteria for DPR that would incorporate a level of public health protection as good as or better than what is currently provided in Calif. by conventional drinking water supplies and IPR systems.**



# Research Needs: Potable Reuse

- Strong interest by WE&RF and SWB, including DPR
- Significant opportunities to advance recycled water
- Build on ongoing research planning efforts



# Research Needs: Potable Reuse

## Treatment

- Non-RO treatment trains
- Optimization of treatment
- Technology validation
- Assessment of treatment performance
- Reliability of treatment

## Monitoring for pathogens and chemicals

- Surrogates and indicators
- Chemical monitoring
  - Chemicals – CECs, knowns and unknowns
  - Non-targeted analysis; Bioassays
- Pathogen monitoring
  - Emerging pathogens
  - Molecular methods; Next generation sequencing

## Operations

Research

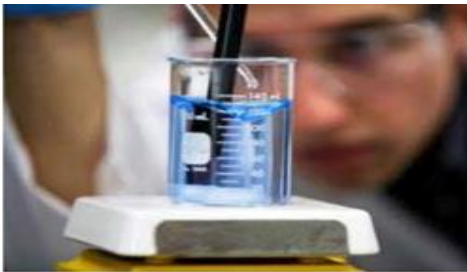
Technology & Innovation

Public Acceptance



### LIFT<sup>2.0</sup> 7 STRATEGIC AREAS OF FOCUS

LIFT is a WERF-WEF program that accelerates water technology demand and adoption and engages the entire water sector in all phases of the innovation process.



glass at a time ...

Helping people understand  
Potable Reuse

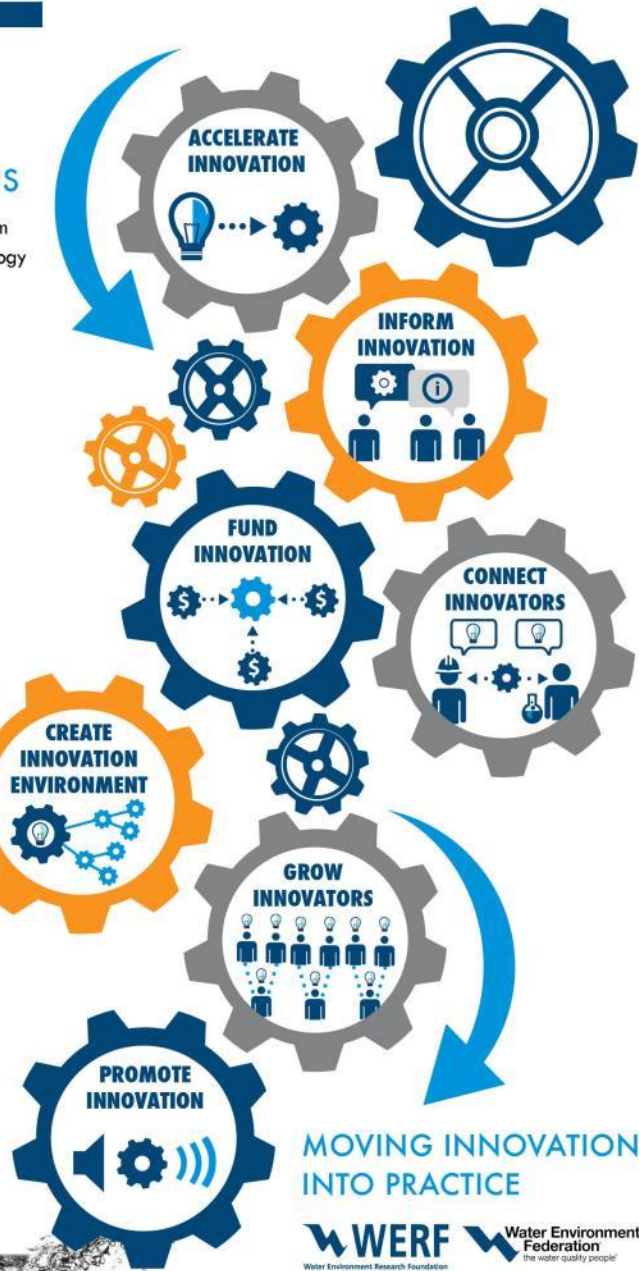
# DOWNSTREAM



# LIFT<sup>2.0</sup>

## 7 STRATEGIC AREAS OF FOCUS

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# LIFT

Leaders Innovation Forum  
for Technology

[www.werf.org/lift](http://www.werf.org/lift)

## Program Components

1. Technology Evaluation Program
2. People and Policy
3. Communication
4. Informal Forum for R&D Managers

# Public Acceptance

Is “public attitude”  
the biggest  
challenge  
to potable reuse?





# Public Perception



Model Communication Plans  
for Increasing Awareness and  
Fostering Acceptance of  
Direct Potable Reuse

**Project:** 13-02

**Status:** Completed Research

**Released:** 2015

WATER REUSE FOR DRINKING | AROUND THE WORLD

HOME LOCATIONS FAQ HELP

WELCOME TO THE GLOBAL CONNECTIONS MAP

Access to clean, reliable, and adequate water supply is paramount to any community's future. Communities around the world face pressure from population growth, climate change and the impact of water management decisions by upstream jurisdictions or countries.

This global connections map spotlights some of the ways in which water is used and reused across the globe for potable reuse. Of course, we must not forget that it is often the case that downstream communities are using the treated used water from upstream communities. This commonplace use and reuse of water for drinking is not shown on the map.

The global connections map brings innovative water purification projects into focus to open the door to more sustainable management. The needs, benefits, safety and technologies of these key projects are highlighted.

The map will evolve over time as more and more projects are added from around the world.

EXPLORE

Map data ©2015 Google, INEGI Imagery ©2015 NASA, TerraMetrics Terms of Use

WATER REUSE Australian Water Recycling Centre of Excellence

## Treatment Technology animations

Ozonation



Reverse Osmosis

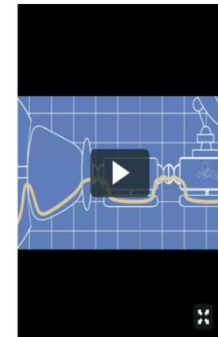


## Think & Drink Water

Sustainability



Systems Thinking



Designed for Purpose



# Changing minds... One pint at a time



**Start a conversation about reuse and the nature of water**

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**Demystify water purification and the urban water cycle**

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**Showcase innovative water technology to inform how water can be used**



# Thank you for listening!

## Questions?

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**CEO, WE&RF**  
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