UPSTREAM STRATEGIES: Future Water Research & Innovation Solutions

# INFRASTRUCTURE

# Treatment

**In the next 10 to 20 years, disruptive challenges to water treatment (drinking water, wastewater, reuse, and stormwater) may affect the ability of water utilities to meet their committed levels of service for their ever-changing service areas. How can utilities continue to manage these growing challenges in a way that allows them to deliver high-quality services and maintain deteriorating infrastructure?**

## CRITICAL FUTURE DISRUPTORS

For the purposes of this effort, a disruptor is defined as something that interrupts an event, activity, or process by causing a disturbance, problem, or opportunity. Disruptors can arise as barriers to normal operations or may present opportunities to do things differently/innovate.

The following items were chosen by a diverse group of water leaders and experts as the most significant future disruptors that water utilities must anticipate and plan for.

### CLIMATE

Unpredictable extreme weather events and drought will exacerbate water quantity and quality challenges. In some cases, water scarcity may drive population migration to areas with more water. It is equally likely, however, that water utilities will continue to be challenged by population growth in arid areas. In these arid climates, there will be an increasing need for additional revenue to meet the continuing demand and the cost of water may rise as its value becomes better understood. Water scarcity will also have implications for agriculture, e.g., food security and availability.

### TECHNOLOGY

Water utility operations, treatment, and monitoring will be continually revolutionized via advances in artificial intelligence, machine learning, utilization of big data, predictive analytics, and more. These technology developments will also have significant implications for the water workforce.

### ENERGY

Water utilities will have more opportunities to take advantage of alternative and/or distributed energy sources for water treatment and transmission. These opportunities may be driven or influenced by national or state and local energy regulations and policies. As alternative energy strategies develop, alternative water supply approaches like desalination may become more viable. Hydrogen-powered water treatment equipment could also become a reality.

### REGULATION/LEGISLATION

New and updated regulations and legislation will impact the water sector. Important areas of emphasis for these updates could include wastewater pretreatment, decentralized systems, energy efficiency, and implementation of costly treatments to address compounds of emerging concern.

## RESEARCH OPPORTUNITIES

Based on these critical future disruptors, experts prioritized the following targeted research areas:

### LEGAL/REGULATORY

Research is needed to inform sound regulations that are based on science and take a holistic view of overall risk reduction. An overarching goal of this research should be to support regulations that are focused on long-term solutions, rather than those driven by short-term political calculus that are limited in scope. It should be explored whether existing legislation including the Safe Drinking Water Act (SDWA) and Clean Water Act (CWA), could be optimized (e.g., update the CWA to account for agricultural runoff). New regulatory opportunities should also be investigated, e.g., "water credits" (like carbon credits) that could be sold/traded between states that share resources.

### REUSE

Research is needed that will further implementation of fit-for-purpose reuse. There are many areas that warrant further exploration, including potable reuse without membranes, optimum strategies for implementation of onsite reuse/treatment, and more.

### TECHNOLOGY

More research is needed on next-generation sensors and monitoring technologies, including within the distribution system, such as better sensors to detect compounds like ammonium and faster and better methods to measure disinfection, thus decreasing the need for lab analysis.

### ENERGY

Research is needed to aid in the transition to more energy efficient treatment and distribution systems as well as to less expensive, climate-friendly, and dependable energy systems (e.g., hydrogen power economy). The research should support a more holistic consideration of resource utilization (energy, chemicals, labor, concrete/land, etc.), as well as additional opportunities for resource recovery at water resource recovery facilities.

### WASTEWATER PROCESSES

Research is needed to further various approaches, such as biological nutrient removal, mainstream anammox, improved digester gas use, and more.