

## Discussion Framework for Development of a Draft Water Reuse Action Plan

### A Collaborative Call for Action: Development of a Water Reuse Action Plan

On February 27, 2019, at a water reuse summit in San Francisco, the U.S. Environmental Protection Agency (EPA) announced the development of a Water Reuse Action Plan that will better integrate federal policy and leverage the expertise of both industry and government to ensure the effective use of the Nation's water resources. The EPA is bringing together experts across the water sector to identify a path forward that will provide more water to users while protecting human health and the environment.

*"The Nation's water resources are the lifeblood of our communities, and the federal government has the responsibility to ensure all Americans have access to reliable sources of clean and safe water,"* said **David Ross, U.S. EPA's Assistant Administrator for Water**. *"There is innovative work happening across the water sector to advance water reuse, and the EPA wants to accelerate that work through coordinated federal leadership."*

A draft of the plan is scheduled for release and public review in September 2019 at the Annual Water Reuse Symposium in San Diego. This Discussion Framework is intended to frame the context for, and inform the development of, a Water Reuse Action Plan.

#### I. Vision

Water reuse can be a valuable means to enhance the availability and effective use of our Nation's water resources and should be considered as part of an integrated water resources management approach to meet the future needs of our Nation. An integrated approach commonly involves a combination of water management strategies (e.g., water supply development, water storage, stormwater management, water use efficiency, and water reuse) and engages multiple stakeholders and needs. The EPA, in collaboration with the Department of Interior, Department of Agriculture, the Department of Energy and other federal agencies, states, tribes, locales, the water sector, and other partners and stakeholders, will work to enhance consideration and application of water reuse through development and implementation of a Water Reuse Action Plan (WRAP).

*For purposes of this discussion framework, "water reuse" includes other common terminology including recycled water, reclaimed water, alternative water supplies, improved water reliability, and water resource recovery.*

The EPA will leverage and continue to engage with other federal agencies, states, tribes, local governments, water utilities, industry, agriculture, and others with keen water interests. The EPA will also be a key partner to implement the [Water Security Grand Challenge](#) with the U.S. Department of Energy, which has elements related to water reuse:

*"The Water Security Grand Challenge will incentivize new technologies aimed at solving one of the most important global challenges of our time – providing access to clean, safe, and secure water. EPA looks forward to partnering with DOE to help bring clean and safe water to communities across the country and find innovative ways to transform non-traditional water sources into resources."*

– EPA Administrator Andrew Wheeler, October 25, 2018

#### II. Business Case - Impetus for Action

The Nation's water resources are the lifeblood of our communities, supporting our economy and way of life. Across the country, we depend upon reliable sources of clean and safe water.<sup>1</sup> Though water reuse is a well-established practice in certain areas, substantial opportunities exist to optimize its consideration and application for many different purposes across the country. For example, forty out of fifty state water managers expect to face freshwater shortages in their states in the next ten years.<sup>2</sup>

<sup>1</sup> EPA Strategic Plan, FY 2018-2022, February 12, 2018

<sup>2</sup> Government Accountability Office (GAO) 2014. Freshwater: Supply Concerns Continue and Uncertainties Complicate Planning. GAO-14-43

Multiple federal and state agencies maintain initiatives that address water reuse (see Sections IV and VI), but improvements in coordination or leveraging could maximize benefits and progress could be accelerated with an integrated, crosscutting strategy and action plan. Congress, multiple states, and stakeholders have increasingly called for action and focus on water reuse, which could be bolstered by federal, state, and watershed-based collaboration, when desired and appropriate.

The literature identifies many motivations for consideration of water reuse as part of a diverse portfolio of water sources to meet current and future water demands, including:

- Widespread adoption of coordinated and integrated water resources management;
- Creating water alternatives in response to prolonged and severe droughts;
- Accommodating population growth and urbanization;
- Substituting reclaimed water for applications that do not require drinking-quality water;
- Protecting aquatic ecosystems through targeted restoration and avoided withdrawals/diversions;
- Addressing groundwater overdrafts and related impacts (land subsidence, saltwater intrusion, etc.);
- Lowering energy costs for treatment and transportation of water;
- Enhancing water security through portfolio diversification and resilience; and
- Augmenting existing water sources to enable long term economic and environmental sustainability.

### III. Use Cases – Possible Examples of Types and Fit-for-Purpose Applications of Water Reuse

Table 1 identifies some broad categories of potential water reuse applications. The information in the table is not exhaustive. The table is followed by brief illustrative examples of current water reuse practices that help to demonstrate applications and opportunities for fuller consideration of water reuse.

**Table 1. Example water reuse categories, applications, and implementation challenges.**

Category	Use Application	Challenges for Implementers
Agriculture & Irrigation	Urban lands/green infrastructure and fixtures	Dual distribution costs and geographic extent limitations; seasonal demand; salinity; cross connection control; state variability in food irrigation water quality standards
	Row Crops (tile drains/irrigation return flows)	
	Livestock	
Drinking Water Source	Direct potable	Energy intensive; state preclusions; public support; risk-based frameworks; infrastructure limitations; broad acceptance of treatment capabilities
	Indirect potable / Augmentation	
	Aquifer storage and recovery	
Non-potable onsite reuse	Rainwater/Stormwater capture and reuse	Prior appropriation, local constraints, lack of data on quality
	Air conditioning condensate	Inefficiency; monitoring data
	Atmospheric water generation/ biomass gasification	Inefficiency; monitoring data
	Building-scale/localized systems	Cost effective treatment technologies, risk assessments re: fit-for-purpose reuse, appropriate safety indicators; varied regulations across the states
National Security & Military	Military operations	Mobility; automation; real-time QA/QC; variable source water quality
	U.S. disaster response	Mobility; uncertainty in source water quality
Impoundments	Recreational/Landscape Impoundments	Nutrient removal needs; ecological risks; dual systems
	Snowmaking	Sometimes a non-point discharge; site ecology; public support
Environmental Restoration	Wetlands	Species sensitivity and site-specific requirements; nutrient removal needs
	Protection from salt water intrusion	
	Stream flow augmentation and wildlife	
	Groundwater/Aquifer recharge	Site hydrogeology; aquifer degradation; advanced treatment needs
	Source water protection	Numerous
Industrial (onsite, imported)	Cooling (effluent reuse, stormwater capture)	Fit-for-use treatment variability; dual distribution; cost of alternative management methods
	Boiler water	
	Other energy and process source water	
	Manufacturing	
Oil and Gas Production	Agriculture, Wildlife/Habitat Support, Industrial Source Water and Oil and Gas Replenishment Water	Availability and validation of cost-effective treatment technologies and adequacy of monitoring data; dual distribution; management methods

The following presents some examples of water reuse that correspond to reuse applications listed above in Table 1:

**Agriculture and Irrigation** – Agriculture is among the most significant of water stewards in the United States. Indications of use of wastewater for agricultural irrigation extends back about 3000 years to ancient Greece.<sup>3</sup> In 1929 the City of Pomona, CA, initiated use of reclaimed water for lawn and garden irrigation.<sup>3</sup> By 2002, nearly half of all reclaimed water produced in California was used for agricultural irrigation.<sup>3</sup> The Monterey Regional Water Pollution Control Facility began delivering 20 million gallons per day (mgd) of recycled water for food crop irrigation in 1998,<sup>4</sup> and today, Monterey One Water recycles around four billion gallons a year for crop irrigation.<sup>5</sup> The Transforming Drainage project across the upper Midwest is exploring the connection of agricultural drainage water management and irrigation.

*“The United States uses 587.76 million gallons of recycled water per day for agricultural irrigation, and this number is on an upward trend.”*  
-- CONSERVE [website](#)

**Direct Potable Reuse (DPR)** – The first demonstrated practice of DPR began in Namibia in 1968 and continues today.<sup>3</sup> The first DPR in the U.S. may have taken place in Chanute, KS, in 1956-1957 when the Neosho River ceased to flow; Chanute reused its treated sewage for five months, recirculating it some eight to fifteen times.<sup>3</sup> In 2013, Wichita Falls and Big Spring, TX, both spurred by drought, received approval from the Texas Commission on Environmental Quality to implement DPR programs.<sup>4</sup> El Paso, TX, launched a pilot facility in 2015 to create water suitable for DPR; its future full-scale facility will produce 10 mgd, helping to serve 36,000 homes.<sup>6</sup> Currently, several states are exploring or developing frameworks for DPR.

**Indirect Potable Reuse (IPR)** – The Upper Occoquan Sewage Authority (UOSA) in Northern Virginia is a commonly cited example of a planned IPR. UOSA’s advanced water reclamation facility, operating since 1978, discharges about 50 mgd to the Occoquan Reservoir, used as a source for drinking water. The reclaimed water represents as little as 10 percent or as much as 90 percent of the reservoir inflow, depending on rainfall conditions.<sup>3</sup> While UOSA is an example of planned IPR, unplanned or “de facto” IPR is very common across the U.S.<sup>4</sup>

**Onsite Non-potable Reuse** – The Alaska Water and Sewer Challenge is spearheading research and development of decentralized systems that enable reuse in rural households, to cost-effectively protect public health and manage water resources while improving affordable access to clean and safe water.<sup>7</sup> In New York City, eight Battery Park City buildings that utilize onsite non-potable reuse consume 50 percent less water and discharge 60 percent less wastewater than similarly-sized buildings in NYC.<sup>8</sup>

*“The need to secure future water supplies, in the face of increasing demand and uncertain water availability, is driving adoption of water reuse. Bluefield Research forecasts municipal water reuse systems will reach over \$21.5 billion between 2017 and 2027, including more than 775 projects in the development pipeline across 19 states.”*  
-- Bluefield Research

**Groundwater Recharge** – In California, Orange County Water District (OCWD) began groundwater injection of reclaimed water in 1975. Today, OCWD injects 100 mgd into the aquifer to replenish water production wells and prevent saltwater intrusion.<sup>4</sup>

**Industrial Reuse** – Opportunities for reuse include cooling water, boiler water, process water, and other needs. In 1995, 0.4 percent of U.S. manufacturing water needs were met with reclaimed water while 60 percent came from surface water and 17 percent from public water supplies.<sup>3</sup> Bethlehem Steel Company in Baltimore, MD, used chlorinated wastewater effluent for steel processing from 1942 through the 1990s.<sup>3</sup> West Basin Water District (Los Angeles, CA) produces water fit for specific needs of various types of customers (e.g., cooling tower and boiler feed water, irrigation).<sup>3</sup>

<sup>3</sup> Metcalf & Eddy. 2007. *Water Reuse: Issues, Technologies and Applications*. Published by McGraw Hill.

<sup>4</sup> Water Environment Federation. 2018. *Water Reuse Roadmap*. Alexandria: Water Environment Federation.

<sup>5</sup> Monterey One Water. 2017. Monterey One Water: Providing Cooperative Water Solutions. Retrieved from <http://www.montereyonewater.org/>.

<sup>6</sup> WaterReuse. 2015. “El Paso Officially Launches ‘First-of-its-kind’ Water Reuse Project.” September 6. <https://waterreuse.org/el-paso-officially-launches-first-of-its-kind-water-reuse-project/>.

<sup>7</sup> Alaska Department of Environmental Conservation. 2019. Alaska Water and Sewer Challenge (AWSC). <https://dec.alaska.gov/water/water-sewer-challenge/>.

<sup>8</sup> Natural Systems Utilities. “Case Studies: Battery Park City.” <https://www.nsuwater.com/case-studies/battery-park-city/>

**Stormwater Capture and Reuse** – Small-scale (rain barrels, rooftop diversions) and large-scale capture of stormwater runoff for treatment, storage and future use is a means of repurposing stormwater for beneficial purposes.

**Environmental Restoration** – Phoenix, AZ, uses treated wastewater to restore and maintain 500 acres of vital wetland and riparian habitat in the Salt River bottomlands.<sup>4</sup>

#### IV. Examples of Efforts Potentially Related to a Water Reuse Action Plan

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##### Federal

- [Presidential Memo: Promoting the Reliable Supply and Delivery of Water in the West](#) (10/19/18) “directs for federal investment in technology and reduction of regulatory burdens to enable broader scale use of recycled water; and programs that promote and encourage innovation, R&D of technology that improve water management, using best available science through real-time monitoring of wildlife and water deliveries.”
- [Water Security Grand Challenge](#) announced by Secretary of Energy Perry (10/25/18) has at least two challenge goals that specifically involve opportunities for water reuse: energy produced water and municipal wastewater.
- Water Infrastructure Improvements for the Nation Act (Public Law 114-322) (WIIN) amended the Water Infrastructure Finance and Innovation Act (WIFIA) to include explicit eligibility for “a water recycling project or a project to provide alternative water supplies to reduce aquifer depletion” (Section 5008 of WIIN). Integrated Planning was also codified as a component of Clean Water Act implementation in 2019.
- America’s Water Infrastructure Act of 2018 specifies Congress’ intent that water reuse is a key part of the national water infrastructure:
  - S.2004 – Sense of Congress that nonpotable sources for industry can relieve supply/demand challenges. Encourages implementing and incentivizing nonpotable reuse to achieve water savings and conservation needs.
  - S.2007 - Authorizes \$10m in FY19/20; requires new grant program to accelerate research and development and technology deployment.
  - S.2017 - Requires the EPA to comprehensively review drinking water treatment technologies and disseminate results.
  - S.4102 - Requires the EPA to disseminate information on cost-effective and alternative technologies, and Report to Congress within one year, and tri-annually thereafter, on alternative wastewater treatment and recycling tech.
- Federal Technology Transfer Authority (15 USC 3710a) and Federal Prize Competition Authority (15 USC 3719) authorizes federal agencies to collaborate on research and development and related efforts.
- [National Drought Resilience Partnership](#) (NDRP), established by Presidential Memorandum (2016), coordinates efforts among agencies to assist in building long-term drought resilience in basins and regions.
- [U.S. Government Global Water Strategy](#) (2017) outlines the Federal Family’s global approach to fostering a water-secure world, describing each Agency’s roles therein, such as Bureau of Reclamation’s charge to foster water reuse and recycling.

##### U.S. EPA

- [EPA Reuse Guidelines](#) (5): 2017 Potable Reuse Compendium and Guidelines for Water Reuse (2012, 2004, 1992 and 1980).
- [Office of Water Study of Oil and Gas Extraction Wastewater Management](#) to solicit perspectives on, and consider management approaches, in unconventional and conventional oil and gas wastewater management.
- Office of Water Microbial Risk Assessments related to Potable Reuse (see “Nappier et al.” in Section X).
- [EPA-New Mexico Memorandum of Understanding](#) to clarify existing regulatory and permitting frameworks related to the way produced water from oil and gas extraction activities can be reused, recycled, and renewed for other purposes. The EPA and New Mexico developed a draft white paper, “Oil and Natural Gas Produced Water Governance in the State of New Mexico,” released November 9, 2018.

#### V. Potential Areas of Focus

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Over the past several years, a range of federal and non-federal activities have been carried out to characterize the potential for water reuse in different sectors or subsectors of the economy. For example, in 2018, the Water Environment Federation released a Water Reuse Roadmap and the report *Mainstreaming Potable Water Reuse in the United States*, was published by ReNUWIt, Johnson Foundation, and the EPA. Other federal agencies and

organizations have developed similar works. The WRAP will not attempt to repeat these recent efforts but will draw on their findings and recommendations to determine what knowledge gaps or actions need to occur to bolster opportunities for water reuse across all sectors of the U.S. economy. International examples and models will also be used, as appropriate, to determine if they would also serve as solutions in the U.S.

Components of a WRAP may include the actions of many water stakeholders and address several thematic areas frequently identified in the literature, including: 1) technological improvements, 2) regulatory/policy aspects, 3) financial initiatives; 4) performance metrics, 5) water information use and availability, and 6) public outreach. Each type of reuse could be evaluated against these six components to provide a greater understanding of the incentives for and barriers to water reuse. Below are some examples of high-level actions and/or information gaps under each of the six components. In facilitating development of the WRAP, the EPA will engage stakeholders and brainstorm action items and specific activities related to water reuse. Actions identified for consideration in the WRAP could be taken by a variety of different water stakeholders or groups with collaborative interests.

### **1. Technological Improvements**

- a. Technology Development, Piloting, Validation – Identifying technological needs and validation requirements; evaluating applications, efficacy, and limitations of existing technologies; and fostering opportunities for onsite and mobile pilot testing to assist regulators and drive costs and feasibility towards “pipe parity” (e.g., closer or equal to other water supplies).
- b. Monitoring and Sensors – Collecting timely, robust, quality data (constituents and surrogates) to (a) verify that water is safe and meets quality expectations, namely online and offline standardized methods to understand reuse water needs and fit for purpose baselines (for example, biological risks and operations for potable reuse; dissolved mineral content for niche manufacturing; or optimizing stormwater management and capture with real-time weather information); and (b) ensure systems operate as designed (e.g., component performance, protection of downstream components).
- c. Concentrate and Brine Management – Determining the management and reclamation opportunities for managing brines/concentrates, with specific focus on areas facing limited viable and environmentally acceptable disposal methods.
- d. Research Coordination and Critical Science Gaps – Building upon decades of research across the Federal and private sector to close any remaining critical gaps.
- e. International Experience – Building upon the extensive technology and reuse practices of the international community (e.g., Israel, Namibia, Singapore, Australia).

### **2. Regulatory/Policy Aspects at All Levels of Government**

- a. Public Health Protection – Exploring establishment of public health benchmarks and guidelines, and risk-based baselines (e.g., pathogen removal targets and other risk-based constituent removal targets), to advance the practice – particularly in types of reuse which lack guidelines/regulatory frameworks – and continuing development and utilization of tools and processes for locales and water managers to evaluate public health risks and ensure any reused water is fit for purpose.
- b. Regulatory and Policy Incentives, Challenges, Barriers, and Facilitation – Creating an environment where reuse can be realistically and routinely considered within a unified framework.
- c. Source Control – Building on existing programs and capabilities such as using local Pretreatment Programs to apply source tracking and control to help protect the quality of recycled municipal wastewater.

- d. Workforce and Operator Training Certification Programs – Fostering a workforce with training and skills to operate complex technologies, and manuals of practice and procurement to support operators and administrators alike.
- e. Addressing Other Regulatory or Institutional Barriers – Considering expanded alternatives for the management and disposal of wastewaters, such as oil and gas produced water, that in turn spur technology development.

### **3. Financing**

- a. Financing and Funding Eligibility – Providing additional funding opportunities and incentives; and ensuring federal and state funding eligibility is clear and can be easily integrated with other funding programs.
- b. Affordability – Bolstering water reuse’s ability to lower the total cost of water, as one of many tools to address burgeoning household water affordability issues around the country.

### **4. Fit for Purpose**

- a. Water Quality Performance Metrics to Assure that Recycled Water Meets Use and User Needs – Helping states and other entities determine frameworks and scale-specific levels of treatment for recycled water depending on intended use (i.e., including potable; ecosystems; groundwater; irrigation/agriculture; boiler/cooling water; etc.) and technical and/or infrastructure specifications.
- b. Transform the Design and Implementation of Agricultural Drainage – Helping states and landowners understand the potential benefits of storing water in the landscape and implement various forward-looking drainage practices to support resilient and productive agricultural systems and improve downstream water quality.
- c. Maximizing Opportunities for Environmental Restoration – Understanding water quality-based capabilities for targeted environmental restoration, such as reducing secondary and/or combined stormwater discharges while improving streamflow and habitat in impaired watersheds.
- d. Identifying Frameworks – Identifying frameworks and design scale ranges for which metrics and standards are needed, desired, and applicable.

### **5. Information about Water Use and Availability**

- a. Data Sharing, Integration and Exchange – Creating the mechanisms for water quality and quantity information to be shared and integrated and usable at the different scales to facilitate integrated water resources management, including water reuse opportunities. This sharing and integrating of water information is often referred to as the “Internet of Water”.<sup>9</sup>
- b. Data Governance – Encouraging watershed-based water information hubs and collaboratives to optimize sharing and integration of information to improve integrated water management.

### **6. Outreach Opportunities**

- a. Public Outreach – Understanding the importance of public acceptance of reused water, and ensuring clear, consistent messaging and risk communication from federal agencies on basic questions related to reuse. Articulating lessons learned. More messaging on a national level of the benefits of reuse and the appropriate and applicable public health and environmental safeguards.
- b. Public Education – Using best-practices in risk communication to help the public understand the level of protection and risk associated with current programs and requirements.
- c. Communication – Facilitating the deployment and dissemination of critical and relevant water reuse-related information and templates for information delivery.
- d. Reuse Case Examples – Identifying successful projects to provide insights on opportunities and barriers to water reuse.

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<sup>9</sup> Aspen Institute. 2017. *Internet of Water: Sharing and Integrating Water Data for Sustainability*. [www.aspeninstitute.org/publications/internet-of-water/](http://www.aspeninstitute.org/publications/internet-of-water/)

## VI. Example Collaborators\* and Potential Owners of Actions in a Water Reuse Action Plan

### Federal Partners on Water

- Council on Environmental Quality
- White House Office of Science & Technology Policy
- National Economic Council
- EPA: OW, ORD, OP, OECA, OMS, OSRTI, Regions 1–10
- Department of Agriculture (USDA) (e.g., NIFA, ERS, ARS, NRCS)
- Department of Interior (DOI) (e.g., BLM, BoR, USGS)
- Department of Commerce (National Oceanic & Atmospheric Administration (NOAA))
- Department of Energy (DOE)
- Army Corps of Engineers

### Other Federal Agencies and Working Groups

- Department of Defense (DoD)
- National Science Foundation (NSF)
- National Research Council
- National Academies of Science, Engineering and Medicine
- NSTC Subcommittee on Water Availability and Quality
- Department of State (DOS)
- National Aeronautics and Space Administration (NASA)
- Centers for Disease Control (CDC)
- Food and Drug Administration (FDA)
- US Agency for International Development (USAID)
- Water Treatment Interagency Working Group (WaTr)

### States

- Association of Clean Water Administrators (ACWA)
- Association of State Drinking Water Administrators (ASDWA)
- Association of State and Territorial Health Officials (ASTHO)
- Groundwater Protection Council (GWPC)
- Specific States (e.g., Virginia; Texas; Georgia; Alaska; California; Florida; Colorado River Basin States)
- Western States Water Council (WSWC)
- Western Coalition of Arid States (WESTCAS)
- Environmental Council of the States (ECOS)/ITRC
- National Governors Association

### NGOs

- WaterReuse Association
- Water Environment Federation (WEF)
- American Water Works Association (AWWA)

- Association of Metropolitan Water Agencies (AMWA)
- The Water Research Foundation (TWRF)
- National Water Research Institute (NWRI)
- National Association of Clean Water Agencies (NACWA)
- National Rural Water Association (NRWA)
- National Association of Clean Water Companies
- US Water Alliance
- Alliance for Water Efficiency
- CA Coastkeeper Alliance
- Conservation X Labs
- Clean Water Action
- Environmental Defense Fund
- Natural Resources Defense Council
- Pacific Institute
- Rural Community Assistance Project (RCAP)
- The Nature Conservancy
- Western Resource Advocates

### Water Sector/Utilities/Regional Partnerships/Locales

- National Blue Ribbon Commission on Onsite Non-potable Water Systems
- Water Utilities (e.g., OCWD, SFPUC, El Paso, HRSD)

### Technology Developers/Providers/Accelerators

- Water Technology Clusters such as The Water Council (Milwaukee)
- Imagine H2O
- Suez, Xylem, Ecolab and many others

### Academia

- University of Arizona - Tucson
- Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)
- UC Berkeley
- Stanford Woods Institute/Water in the West
- Center of Excellence at the Nexus of Sustainable Water Reuse, Food and Health (CONSERVE)
- University of Colorado CIRES
- Colorado State University Water Center
- Columbia University
- Southern CA Coastal Water Research Program
- The Water Institute at UNC
- University of South Florida

## VII. The EPA Water Reuse Team

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\* Not intended to be an exhaustive list.

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### **VIII. Informing Development of the Water Reuse Action Plan**

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As the EPA facilitates among federal and state agencies, tribes, and across the water sector, potentially key considerations include:

- Maximizing opportunities for public engagement to ensure broad participation, including identifying scheduled conferences, forums, and meetings in various sectors pursuing water reuse (such as agriculture, municipal, and industry);
- Including the proper scope and elements in the WRAP;
- Creating an overarching emphasis on integrated water resources management where water reuse is considered;
- Identifying specific actions that can be taken now and in the future by federal agencies, states, tribes, local governments, and the entire water sector;
- Addressing how federal agencies and states can improve coordination in their activities related to water reuse;
- Identifying barriers, opportunities, and areas of focus that should be addressed by the WRAP;
- Ensuring that the WRAP reflects and builds upon existing works by the water sector related to water reuse; and
- Building on the knowledge and experience of the international community.

### **IX. Water Reuse and Related Forums**

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Recent and upcoming meetings and forums are opportunities to gain insights. This list, which is not intended to be exhaustive, identifies example opportunities to engage in discussion to inform the development of the draft water reuse action plan.

#### Attended Events

- Resource Revolution of Water Reuse (Wharton, IGEL, Suez), San Francisco, February 27, 2019
- 2019 WaterReuse California Annual Conference, Orange County, CA, March 17-19
- ACWA Mid-Year Meeting, Alexandria, VA, March 19-20, 2019
- ASDWA Member Meeting 2019, Alexandria, VA, March 25-27, 2019
- National Water Week/Water Policy Fly In, Washington, DC, March 31-April 1, 2019
- National Blue Ribbon Commission for Onsite Non-potable Water Systems Annual Meeting, Denver, CO, April 10-12, 2019

#### Upcoming Events

- 2019 Water Microbiology Conference, The Water Institute at Chapel Hill, NC, May 13-16
- NACWA National Pretreatment Workshop, Tacoma, WA, May 14-17, 2019
- AWWA Annual Conference and Expo, Denver, CO, June 9-12, 2019
- ASDWA/EPA Data Management Users Conference, Atlanta, GA, July 22-25, 2019
- ACWA Annual Meeting, Austin, TX, Aug. 27-29, 2019
- 34<sup>th</sup> Annual WaterReuse Symposium, San Diego, CA, Sept. 8-11, 2019
- US Water Alliance One Water Summit 2019, Austin, TX, Sept. 18-20, 2019
- WEFTEC, Chicago, Sept. 21-25, 2019
- AWWA Water Quality Technology Conference, Dallas, TX, Nov. 3-7, 2019



## X. Relevant Published Literature

The list below represents literature reviewed for purposes of developing this Discussion Framework. Action opportunities identified in this and other literature will inform the WRAP. This list is not intended to be exhaustive.

- Absar, Mariya et al. n.d. *Life Cycle and Cost Assessments of Atmospheric Water Generation Technologies and Alternative Potable Water Emergency Response Options*. Under clearance. ORD-028439.: EPA/600/X-18/331.
- American Water Works Association. 2014. *G481-14 – Reclaimed Water Program Operation and Management*.
- American Water Works Association AWWA. 2018. *G485-18 Direct Potable Reuse Program Operation and Management*.
- American Water Works Association. 2017. *M50 Water Resources Planning, Third Edition*.
- American Water Works Association. 2016. *Potable Reuse 101: An Innovative and Sustainable Water Supply Solution*.
- American Water Works Association AWWA. 2018. *M62 – Membrane Applications for Water Reuse*. AWWA.
- Arden, Sam, and Mark Brown. Xin (Cissy) Ma. 2018. "Energy Analysis of Constructed Wetland for Greywater Recycle and Reuse." *Science of the Total Environment (630)* 587-599. ORD-024459.
- Army Public Health Center. April 2017. Review of the Applicability of Published Water Reuse Guidelines for Contingency Operations. PHIP No. 39-06-0417.  
<https://phc.amedd.army.mil/PHC%20Resource%20Library/PHIP-39-06-0417-WaterReuseGuidelines-2017.pdf>
- Bluefield Research. 2017. *U.S. Municipal Water Reuse: Opportunities, Outlook & Competitive Landscape 2017-2027*.
- California Urban Water Agencies. 2019. Guiding Regional Reuse Options - A Distributed Systems Approach.
- Cashman, Sarah et al. July 2017. "Holistic evaluation of decentralized water reuse: life cycle assessment and cost analysis of membrane bioreactor systems in water reuse implementation." *International Water Association*.
- Cashman, Sarah et al. 2018. "Energy and greenhouse gas life cycle assessment and cost analysis of aerobic and an-aerobic membrane bioreactor systems: Influence of scale, population density, climate, and methane recovery." *Bioresource Technology (254)* 56-66. ORD-018382.
- Cashman, Sarah et al. 2016. *Life Cycle Assessment and Cost Analysis of Water and Wastewater Treatment Options for Sustainability: Influence of Scale on Membrane Bioreactor Systems*. Environmental Protection Agency. EPA/600/R-16/243. ORD-019901.
- Christian-Smith, Juliet and Peter H. Gleick. 2012. *A Twenty-First Century US Water Policy*. Oxford University Press.
- Colorado Energy Office and Colorado Mesa University. 2014. Produced Water Beneficial Use Dialogue: Opportunities and Challenges for Re-Use of Produced Water on Colorado's Western Slope.
- Colorado General Assembly. 2018. House Bill 18-1093, Concerning the allowable uses of reclaimed domestic wastewater, and, in connection therewith, allowing reclaimed domestic wastewater to be used for food crops and making an appropriation.
- Colorado Water Quality Control Commission. 2018. Regulation No. 84 - Reclaimed Water Control Regulation, 5 CCR 1002-84.
- Colorado Water Quality Control Division. 2017. Safe Drinking Water Program – Immediate Staff and Service Level Reductions.
- Douglas, B. 2019. *Direct Water Reuse in New England – Today & Tomorrow*. Presentation at NEWEA, Boston, MA.
- Engelke, P., Michel, D., Atlantic Council. 2016. *Toward Global Water Security*. <https://www.atlantic-council.org/publications/reports/toward-global-water-security>.
- Freedman, Jon, C. Enssle. 2015. Addressing Water Scarcity Through Recycling and Reuse: A Menu for Policymakers.
- Harris-Lovett, S.R. et al. 2015. "Beyond User Acceptance: A Legitimacy Framework for Potable Water Reuse in California." *Environmental Science and Technology (49)* 7552-7561. doi:10.1021/acs.est.5b00504.

- Harris-Lovett, Sasha, Judit Lienert, and David L. Sedlak. 2018. "Towards a New Paradigm of Urban Water Infrastructure: Identifying Goals and Strategies to Support Multi-Benefit Municipal Wastewater Treatment." *Water* 10(9) 1127. <https://doi.org/10.3390/w10091127>.
- Jahne, Michael A. et al. 2017. "Simulation of enteric pathogen concentrations in locally-collected greywater and wastewater for microbial risk assessments." *Microbial Risk Analysis* (5) 44-52. doi:<https://doi.org/10.1016/j.mran.2016.11.001>.
- Keeler, B.L., Gourevitch, J.D., Polasky, S., Isbell, F., Tessum, C.W., Hill, J.D., Marshall, J.D. 2016. "The social cost of nitrogen." *Science Advances* (2): e1600219.
- Mack EA, Wrase S. 2017. A Burgeoning Crisis? A Nationwide Assessment of the Geography of Water Affordability in the United States. PLOS ONE 12(1): e0169488. <https://doi.org/10.1371/journal.pone.0169488>.
- Medina, Victor F., Richard J. Scholze, Scott A. Waisner, and Chris S. Griggs. 2015. "Energy and Resource Recovery from Wastewater Treatment: State of the Art and Potential Application for the Army and DOD." US Army Corps of Engineers, Engineer Research and Development Center (ERDC). <https://apps.dtic.mil/dtic/tr/fulltext/u2/a619808.pdf>.
- Metcalf & Eddy. 2007. *Water Reuse: Issues, Technologies and Applications*. Published by McGraw Hill.
- Morelli, Ben et al. n.d. *Life Cycle Assessment and Cost Analysis of Distributed Mixed Wastewater and Graywater Treatment for Water Recycling in the Context of an Urban Case Study*. EPA report: EPA/600/X-18/280. Under clearance. ORD-028027.
- Nappier, S.P., J.A. Soller, and S. Eftim. 2018. "Potable Water Reuse: What Are the Microbiological Risks?" *Current Environmental Health Reports* 5(2) 283-292. doi:10.1007/s40572-018-0195-y.
- National Academies of Sciences, Engineering and Medicine. 2018. *Future Water Priorities for the Nation: Directions for the U.S. Geological Survey Mission Area*. Washington, District of Columbia: National Academies Press. <http://nap.edu/25134>.
- National Academies of Sciences, Engineering, and Medicine. 2016. *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/21866>.
- National Research Council. 2012. *Understanding Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater*. Washington, DC: The National Academies Press. doi:<https://doi.org/10.17226/13514>.
- National Research Council. 1996. *Use of Reclaimed Water and Sludge in Food Crop Production*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/5175>.
- NSF International. 2011. Standard 350 and 350-1: Onsite Water Reuse. NSF/ANSI.
- O'Neill, P and JP Dobrowoiski. 2005. *Water Security White Paper*. Cooperative State Research, Education, and Extension Service Agricultural.
- Page, M., MacAlister, B., Hur, A., Jenicek, E., and D. Crokek (2017). *Distributed Water Reuse Systems in Military Settings*. *Worldwater: Water Reuse and Desalination*.
- Paltiel, O, G Fedorova, G Tadmor, et al. 2016. Human Exposure to Wastewater-Derived Pharmaceuticals in Fresh Produce: A Randomized Controlled Trial Focusing on Carbamazepine. *Environmental Science and Technology* 50: 4476-4482. Presidential Memo. 2018. *Promoting the Reliable Supply and Delivery of Water in the West*. [https://www.whitehouse.gov/presidential-actions/presidential-memorandum-promoting-reliable-supply-delivery-water-west/?mc\\_cid=46ed9122f7&mc\\_eid=92f6fce182](https://www.whitehouse.gov/presidential-actions/presidential-memorandum-promoting-reliable-supply-delivery-water-west/?mc_cid=46ed9122f7&mc_eid=92f6fce182).
- Rice, J. 2014. *Modeling Occurrence and Assessing Public Perceptions of De Facto Wastewater Reuse across the USA*. Arizona State University.
- River Network. 2018. *Annual Report*. <https://www.rivernetwork.org/wp-content/uploads/2018/12/RiverNetwork-AnnualReport-2018.pdf>.
- Salveson. 2018.
- Schoen, ME, and J Garland. 2017. "Review of pathogen treatment reductions for onsite non-potable reuse of alternative source waters." *Microbial Risk Analysis* 25-31. doi:<https://doi.org/10.1016/j.mran.2015.10.001>.

- Schoen, ME, MA Jahne, and JL Garland. 2018. "Human Health Impact of Cross-Connections in Non-Potable Reuse Systems." *Water* 10(10) 1352. doi:doi:10.3390/w10101352 .
- Schoen, ME, NJ Ashbolt, MA Johne, and JL Garland. 2017. "Risk-Based Enteric Pathogen Reduction Targets for Non-Potable and Direct Potable Use of Roof Runoff, Stormwater, and Greywater." *Microbial Risk Analysis* 32-43. doi:https://doi.org/10.1016/j.mran.2017.01.002.
- Sedlak, David. 2015. *Water 4.0*. Yale University Press.
- Sheikh, B. 2017. Significance to human health of carbamazepine detected in fruits and vegetables irrigated with recycled water. *Water Science and Technology* 75(5): 1059-1062.
- Soller, JA et al. 2017. "Evaluation of microbiological risks associated with direct potable reuse." *Microbial Risk Analysis* 3-14. doi:https://doi.org/10.1016/j.mran.2016.08.003.
- Soller, JA, SE Eftim, and SP Nappier. 2018. "Direct potable reuse microbial risk assessment methodology: Sensitivity analysis and application to State log credit allocations." *Water Research* 128(1) 286-292. doi:10.1016/j.watres.2017.10.034.
- State of California. 2016. California Water Action Plan: Actions for Reliability, Restoration and Resilience.
- Tasker, TL et al. 2018. "Environmental and Human Health Impacts of Spreading oil and Gas Wastewater on Roads." *Environmental Science and Technology* 52(12) 7081-7091. doi:10.1021/acs.est.8b00716.
- The Water Research Foundation. 2017. "Blueprint for One Water." <http://www.waterrf.org/PublicReportLibrary/4660.pdf>.
- The Water Research Foundation. 2019. *Agricultural Use of Recycled Water: Impediments and Incentives*.
- The Water Research Foundation. 2018. Review of Non-Culture-Based Methods for Pathogen Monitoring in Potable Reuse. Project No. Reuse-14-17/4768.
- U.S. Army Public Health Command. March 2014. Water Reuse in Contingency Operations. [https://phc.amedd.army.mil/PHC%20Resource%20Library/TG364a\\_Water\\_Reuse\\_in\\_Contingency\\_Operations\\_2014.pdf](https://phc.amedd.army.mil/PHC%20Resource%20Library/TG364a_Water_Reuse_in_Contingency_Operations_2014.pdf)
- U.S. Congress. 2016. Water Infrastructure Improvements for the Nation Act (Public Law 114-322).
- United States Conference of Mayors. 2017. The 85th Annual Meeting of the Conference of Mayors.
- United States Environmental Protection Agency and the State of New Mexico. 2018. Oil and Gas Produced Water Governance in the State of New Mexico – Draft White Paper. <http://www.emnrd.state.nm.us/wastewater/documents/Oil%20and%20Gas%20Produced%20Water%20Governance%20in%20the%20State%20of%20New%20Mexico%20Draft%20White%20Paper.pdf>
- United States Environmental Protection Agency. 2018. *2017 Potable Reuse Compendium*. EPA/810/R-17/002. [https://www.epa.gov/sites/production/files/2018-01/documents/potablereusecompendium\\_3.pdf](https://www.epa.gov/sites/production/files/2018-01/documents/potablereusecompendium_3.pdf).
- . 2018. "FY 2018-2022 U.S. EPA Strategic Plan." February. <https://www.epa.gov/sites/production/files/2018-02/documents/fy-2018-2022-epa-strategic-plan.pdf>.
- . 2018. "National Water Program Guidance FY 2018-2019." 800D17001. <https://www.epa.gov/sites/production/files/2017-09/documents/fy18-19-ow-npm-guidance.pdf>.
- . 2018. *Detailed Study of the Centralized Waste Treatment Point Source Category for Facilities managing Oil and Gas Extraction Wastes*. EPA/821/R- 18/004.
- . 2018. Public Meeting EPA Oil and Gas Extraction Study Effluent Guidelines Program. October 9, 2018. Washington, DC. [https://www.epa.gov/sites/production/files/2018-10/documents/epa\\_oil-gas-study\\_public-meeting\\_10-09-2018.pdf](https://www.epa.gov/sites/production/files/2018-10/documents/epa_oil-gas-study_public-meeting_10-09-2018.pdf).
- . 2015. "Safe and Sustainable Water Resources Strategic Research Action Plan 2016-2019." November. EPA 601/K-15/004. [https://www.epa.gov/sites/production/files/2015-10/documents/strap\\_2016\\_sswr\\_508.pdf](https://www.epa.gov/sites/production/files/2015-10/documents/strap_2016_sswr_508.pdf).
- . 2012. *2012 Guidelines for Water Reuse*. EPA/600/R-12/618. <https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/ar/AR-1530.pdf>.
- . 2012. Integrated Municipal Stormwater and Wastewater Planning Approach Framework.
- . 2012. Total Water Management. Office of Research and Development National Risk Management Research Laboratory. EPA/600/R-12/551.

- . 1972. Water Supply-Wastewater Treatment Coordination Study.
- United States Environmental Protection Agency, Reinventing the Nation's Urban Water Infrastructure (ReNUWIt), and the Johnson Foundation at Wingspread. 2018. "Mainstreaming Potable Water Reuse in the United States: Strategies for Leveling the Playing Field." April. [https://www.epa.gov/sites/production/files/2018-04/documents/mainstreaming\\_potable\\_water\\_reuse\\_april\\_2018\\_final\\_for\\_web.pdf](https://www.epa.gov/sites/production/files/2018-04/documents/mainstreaming_potable_water_reuse_april_2018_final_for_web.pdf).
- United States Government Accountability Office. 2014. "Freshwater: Supply Concerns Continue, and Uncertainties Complicate Planning." GAO-14-430. <https://www.gao.gov/assets/670/663343.pdf>.
- US Bureau of Reclamation. 2014. "Development of Methodologies to Evaluate the Environmental, Financial, and Social Benefits of Water Reuse Projects." <https://www.usbr.gov/research/projects/detail.cfm?id=4180>.
- US Bureau of Reclamation. 2016. "WaterSMART Progress Report 2010-2016." December. <https://www.usbr.gov/watersmart/docs/2016/2016watersmartprogressreport.pdf>.
- US Department of Agriculture, Research, Education and Economics Mission Area. 2004 "Agriculture Water Security Listening Session Final Report."
- US Department of Agriculture Agriculture Research Service. 2016. "Water Availability and Watershed Management Action Plan 2016-2020." *National Program 211: Water Availability and Watershed Management*. <https://www.ars.usda.gov/natural-resources-and-sustainable-agricultural-systems/water-availability-and-watershed-management/docs/action-plans/>.
- US Department of Agriculture, National Institute of Food and Agriculture. 2019. *Managing Water for Increased Resiliency of Drained Agricultural Landscapes*. <https://transformingdrainage.org/>.
- US Department of Agriculture. 2017. "Report to the President of the United States from the Task Force on Agriculture and Rural Prosperity." *Task Force on Agriculture and Rural Prosperity*. October 21. <https://www.usda.gov/sites/default/files/documents/rural-prosperity-report.pdf>.
- US Department of Energy. 2018. *Water Security Grand Challenge*. <https://www.energy.gov/eere/water-security-grand-challenge>.
- US Department of State and US Agency for International Development. 2017. "US Government Global Water Strategy." <https://www.state.gov/documents/organization/275842.pdf>.
- US Water Alliance and Water Research Foundation. 2017. "A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems." *National Blue Ribbon Commission for Onsite Non-potable Water Systems*. <http://uswateralliance.org/sites/uswateralliance.org/files/publications/NBRC%20GUIDEBOOK%20FOR%20DEVELOPING%20ONWS%20REGULATIONS.pdf>.
- US Water Alliance. 2017. "One Water for America Policy Framework." <http://uswateralliance.org/sites/uswateralliance.org/files/publications/One%20Water%20for%20America%20Policy%20Framework%20Executive%20Summary.pdf>.
- . n.d. "Resources for Onsite Non-potable Water Programs." *National Blue Ribbon Commission for Onsite Non-potable Water Systems*. <http://uswateralliance.org/initiatives/commission/resources>.
- . n.d. "Making the Utility Case for Onsite Non-potable Water Systems." *National Blue Ribbon Commission for Onsite Non-potable Water Systems*. [http://uswateralliance.org/sites/uswateralliance.org/files/publications/NBRC\\_Utility%20Case%20for%20ONWS\\_032818.pdf.pdf](http://uswateralliance.org/sites/uswateralliance.org/files/publications/NBRC_Utility%20Case%20for%20ONWS_032818.pdf.pdf)
- Water Environment Federation. 2018. *Water Reuse Roadmap*. Alexandria: Water Environment Federation.
- Water Research Foundation. 2017. "Potable Reuse Research Compilation: Synthesis of Findings." <http://www.waterrf.org/Pages/Projects.aspx?PID=4645>.
- Water Research Foundation. 2018. "White Paper on Water Reuse in Hydraulic Fracturing." Project No. Reuse-14-05/4927.
- Water Research Foundation. 2018. "Reuse in Fracking." Project Number Reuse-14-05/4927.
- WaterReuse Association. 2018. "Proceedings of the 33rd Annual WaterReuse Symposium, September 9-12, 2018."
- . 2014. "The Opportunities and Economics of Direct Potable Reuse." <https://watereuse.org/watereuse-research/the-opportunities-and-economics-of-direct-potable-reuse/>.

- . n.d. "Water Reuse: Transforming Water, Sustaining Our Future." <https://watereuse.org/wp-content/uploads/2018/04/Water-Reuse-Transforming-Water-Sustaining-Our-Future.pdf>.
- WaterReuse Association, American Water Works Association, Water Environment Federation, and National Water Research Institute. 2015. "Framework for Direct Potable Reuse." Project 14-20. <https://watereuse.org/wp-content/uploads/2015/09/14-20.pdf>.
- WaterReuse Colorado. 2018. "Advancing Direct Potable Reuse to Optimize Water Supplies and Meet Future Demands; Executive Summary".
- WaterReuse Colorado. 2018. "Advancing Direct Potable Reuse to Optimize Water Supplies and Meet Future Demands; Technical Memorandum 1: Development of DPR Regulations in Colorado".
- WaterReuse Colorado. 2018. "Advancing Direct Potable Reuse to Optimize Water Supplies and Meet Future Demands; Technical Memorandum 2: Communications and Outreach Plan for Direct Potable Reuse in Colorado".
- WaterReuse Colorado. 2018. "Advancing Direct Potable Reuse to Optimize Water Supplies and Meet Future Demands; Technical Memorandum 3: Potable Reuse Planning Tools and Case Studies".
- Western Resource Advocates. 2017. A Survey of Key States' Regulatory Approaches to Water Reuse.
- Western States Water Council. 2012. *Water Reuse in the West: State Programs and Institutional Issues*.
- World Health Organization. 2017. "Potable Reuse: Guidance for Producing Safe Drinking Water." <http://apps.who.int/iris/bitstream/handle/10665/258715/9789241512770-eng.pdf;jsessionid=1CA76772277CB1A8E6362F287EC5F496?sequence=1>.
- World Health Organization. 1989. *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture*.

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