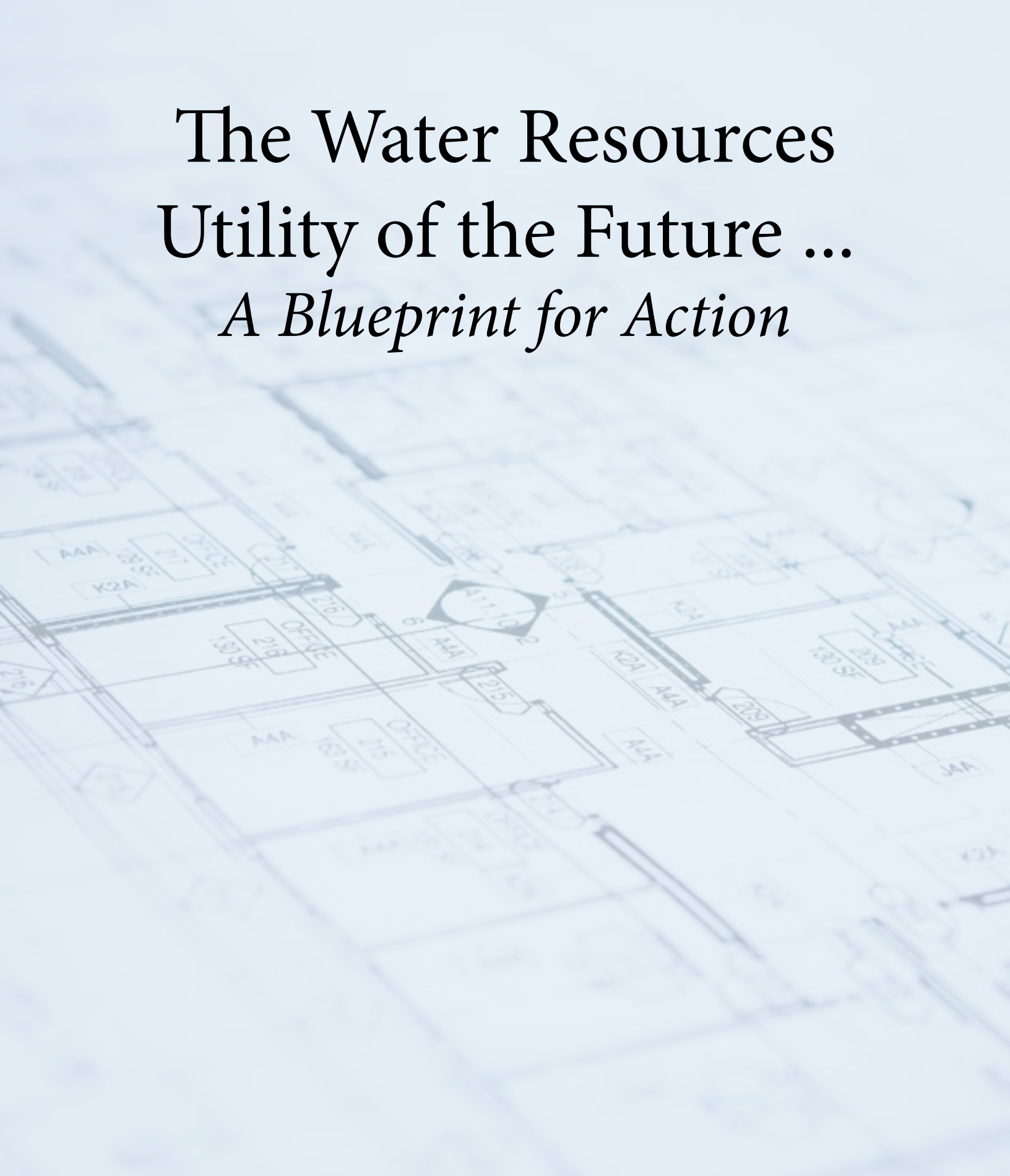
The Water Resources Utility of the Future ...

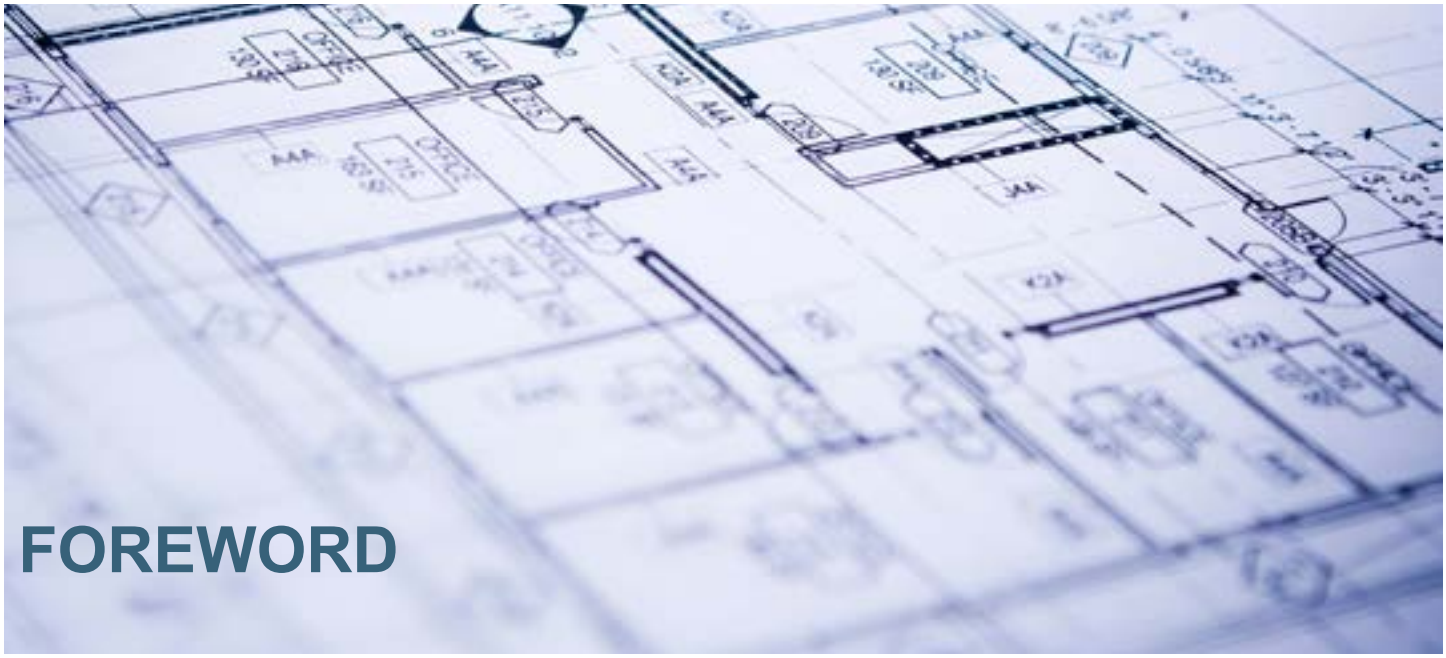
A Blueprint for Action



NACWA
A Clear Commitment to America's Waters

WERF

Water Environment Federation®
the water quality people™



FOREWORD

The National Association of Clean Water Agencies (NACWA), the Water Environment Research Foundation (WERF), and the Water Environment Federation (WEF) are pleased to release the *Water Resources Utility of the Future...Blueprint for Action*. Work on this document began in earnest in September 2012 and has been shepherded along by the strong efforts of a joint Steering Committee made up of three representatives from each of the three organizations as well as by a diverse Task Force of 49 experts representing a broad cross-section from the three organizations' memberships. The Steering Committee ensured the *Blueprint* remained both targeted and comprehensive, and the Task Force provided data, input, editing, and insight throughout the drafting process.

This *Blueprint* was placed on a fast-track for finalization to ensure that Utility of the Future (UOTF) issues are front and center as the 113th Congress and incoming Administration develop their environmental priorities. The audience for this *Blueprint,* however, is broader than just federal policy makers and includes local utility managers, private-sector interests, state and local governments, and many others within the clean water, drinking water, energy, and agricultural communities.

The three organizations have different missions and strengths—these include advocacy, technical input, outreach/communications, scientific research, data collection and media relations. Each organization will cull from this document to determine which particular UOTF priorities to advance. Wherever possible, however, the three organizations will work together to advance shared objectives and will seek to encourage the array of organizations that make up the clean water sector to review this document closely and work to advance the UOTF objectives outlined in the *Blueprint* as well.

It is critical to understand that the *Blueprint* is a living document, and that new ideas under the UOTF umbrella will continue to be added. This document represents an opening salvo in the effort to define and tie together a diverse realm of resource recovery activities and innovative approaches, many of which were never contemplated, and likely could never have been foreseen, 40 years ago when the Clean Water Act was enacted.

This project was advanced because a group of industry leaders arrived at a shared realization that the challenges (and opportunities) faced by wastewater agencies are unprecedented and that some of the paradigms

that have been in place for decades are changing to meet these challenges. This *Blueprint* underscores the need for the clean water sector to work together to shape the landscape of clean water going forward. It also highlights the type of collaboration that is needed to ensure a sustainable future that minimizes waste, maximizes resources, protects the ratepayer, improves the community, and embraces innovation in an unprecedented manner.

The joint Steering Committee and Task Force that did the hard work to make this *Blueprint* possible constitutes a model that is now in place not only for further joint efforts under the UOTF banner but potentially for other efforts that can advance the clean water sector's lofty objectives. We sincerely hope you find this document as fascinating and useful to read as our organizations did creating it!

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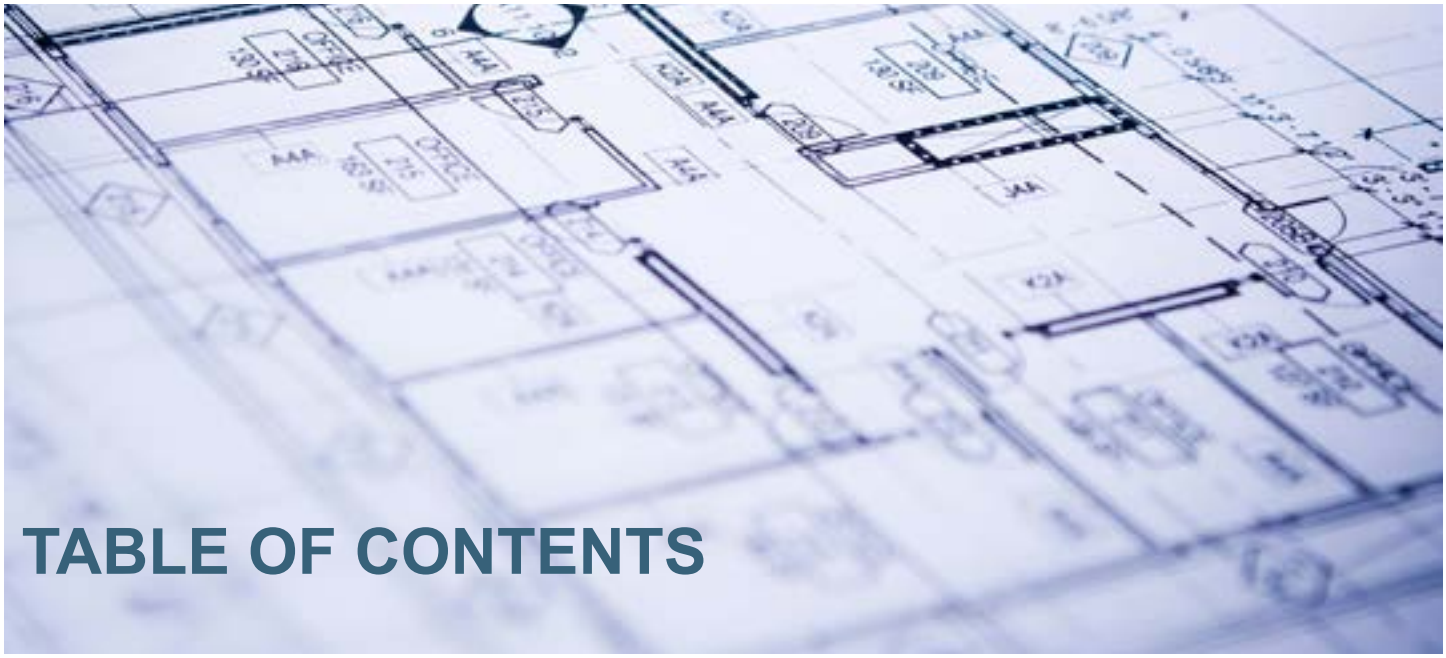

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EXECUTIVE SUMMARY

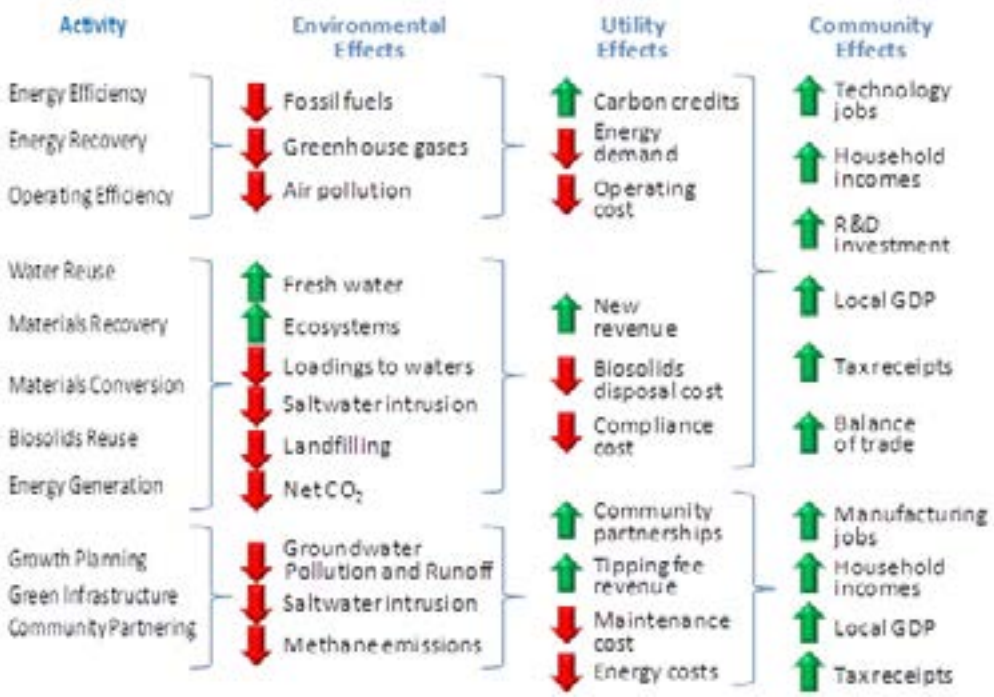
The clean water paradigm in the United States is changing. The Water Resources Utility of the Future (UOTF) will transform the way traditional wastewater utilities view themselves and manage their operations. They also will transform their relationships with their communities and their contributions to local economies. This *Blueprint* presents the clean water industry's vision for the future and a series of actions that will help deliver this vision.

Today's utilities have evolved and matured over decades. Originally technical engineering entities, utility managers now embrace sophisticated management approaches and have developed innovative finance capabilities. These institutions have accomplished many of their goals—they are operationally efficient collectors and managers of household and industrial wastewaters and protectors of the quality of the Nation's waterways. In recognition of these achievements, these utilities are increasingly renaming themselves "water resources recovery facilities" or "clean water agencies."

The most progressive of today's clean water agencies are defining the UOTF. Instead of solely collecting and transporting wastewaters as far downstream as possible to central treatment plants where water is cleansed to meet permit limits prior to discharge to waterways, the UOTF transforms itself into a manager of valuable resources, a partner in local economic development, and a member of the watershed community seeking to deliver maximum environmental benefits at the least cost to society. It does this by reclaiming and reusing water; extracting and finding commercial uses for nutrients and other constituents; capturing waste heat and latent energy in biosolids and liquid streams; generating renewable energy using its land and other horizontal assets; and using green infrastructure to manage stormwater but also to improve urban quality of life more broadly.

These actions benefit the utility in the form of reduced costs and increased revenues. But they also deliver environmental, economic, and social benefits both locally and nationally.

Because we have examples of these sorts of innovations and outcomes, it is tempting to conclude that no further action is needed. Indeed, there are signs that the market for innovation in the clean water sector is beginning to bear fruit after many years of trial and error. But resistance to change is strong, reinforced by regulatory pressures, strained utility budgets, political reluctance to raise rates, customer confusion about the benefits of



innovation, skyrocketing demands for capital competing for every dollar, risk and regret associated with technology failure, and venture capital looking elsewhere for faster and safer returns.

This *Blueprint for Action* examines these barriers, suggests incentives for innovation, and compiles a series of actions that could change the dynamics of this industry. It asks the U.S. Congress to take a major role legislatively to ensure that the Clean Water Act and other authorizing statutes fully support public and private enterprises across the clean water industry as they make the transition to the UOTF. Some actions call for legislative or regulatory changes to sanction watershed-based solutions to the Nation's biggest water quality challenges. These would enable all sources of water quality contaminants to work together on socially cost-effective, market-based solutions while respecting the regulatory framework that has served the country well for decades. Other actions call for modest changes to encourage water reuse and water conservation where it is feasible, needed, and cost-effective and for similarly incremental changes to enable clean water agencies to fully recover waste heat and energy and to produce clean, renewable energy at their facilities.

Other actions address financial and risk allocation conventions: focusing disparate federal financial support programs on UOTF objectives; maximizing efficient water use and reuse for new government buildings where it is environmentally and economically feasible to do so; stimulating the pace of technology innovation with a new advanced research and development program for clean water; and implementing pooled risk-sharing strategies and reciprocity for technology approval across the 50 states, both aimed at boosting adoption rates for new technologies.

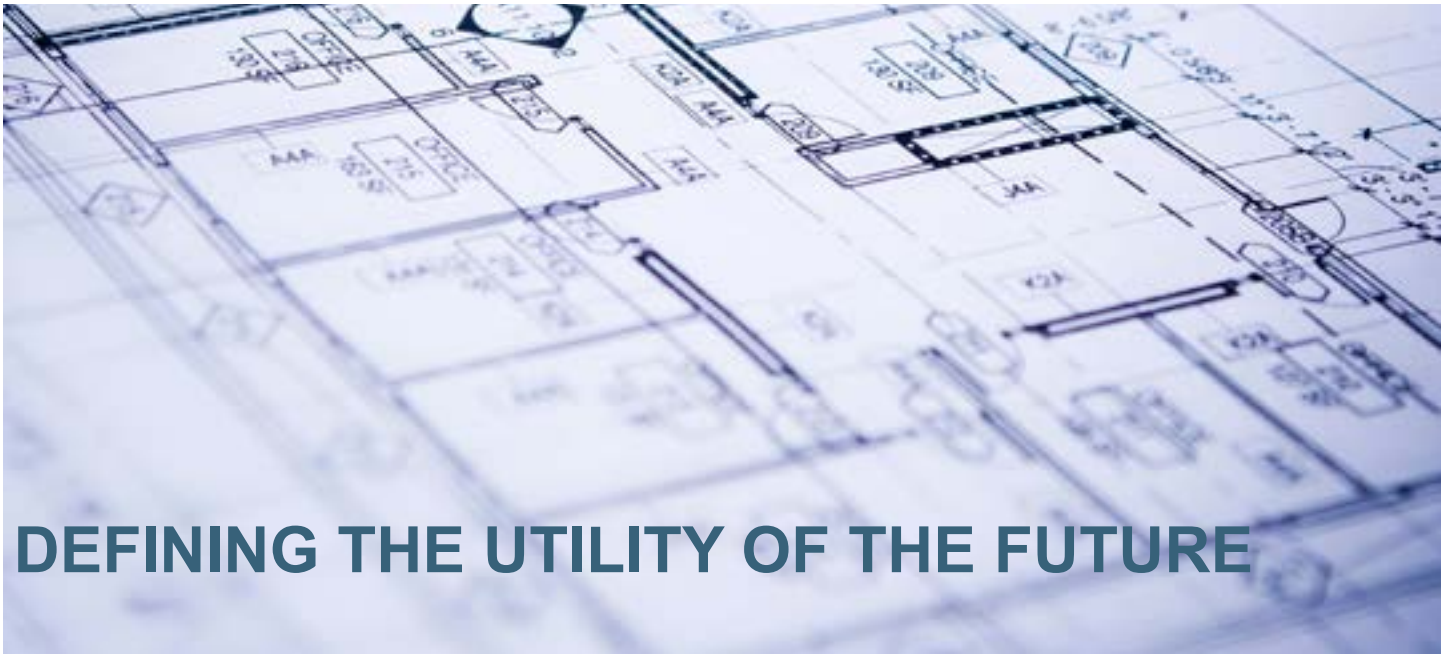
Still others call for institutional or programmatic changes that for the most part, the clean water sector itself can implement working more closely with other municipal leadership and, in some cases, state and/or federal regulators. Stronger support for green infrastructure from within the sector could help go beyond cost-effective stormwater control to frame a broader conversation about fundamental urban design. New models for integrated watershed planning would engage the public, civic leadership, drinking water utilities, and infrastructure professionals to make better decisions.

Finally, the *Blueprint* makes a strong case that clean water agencies must continue to strengthen their institutions though productivity improvement processes/decision support tools such as Lean, Six Sigma, and sustainability-driven environmental management systems. The UOTF will increasingly use social media and smart technology to interact with customers and deliver services more efficiently. It will standardize operator certification to create a better trained and more mobile workforce. These approaches help ensure that the sector performs at peak levels so that external resources will have the greatest impact.

There should be little doubt that all of these changes to the status quo can have profound results. But the world will change even as the sector changes. This *Blueprint*, therefore, also calls for bold, transformational thinking and cooperation in our advocacy, in research and development, and in education and outreach efforts. To shape the future, the *Blueprint* calls for creation of a Congressional caucus where water sector experts can collaborate with legislators to help drive UOTF initiatives and craft a 21st century watershed act that builds on 40 years of Clean Water Act achievements but embraces UOTF initiatives more fully. As well, the *Blueprint* calls for an intergovernmental solution to improve the resilience of the Nation's infrastructure and communities in response to extreme weather events like Hurricanes Sandy, Irene, or Katrina. It asks professional organizations that represent the clean water industry to work together to create the "industry of the future," notably, by compiling a knowledge base of UOTF achievements and by working with the Environmental Protection Agency (EPA),other federal agencies, and the U.S. Congress to implement key elements of this *Blueprint*. And, it calls on the states to develop or support water markets that address long- and short-term shortages in the face of drought.

At this early stage, one cannot fully envision the limits to this new paradigm. But, each clean water agency will take a somewhat different path from handlers of wastewater to managers of sustainable resources; from regulated entities seeking permit compliance to watershed-scale environmental leaders seeking least-cost/highest return environmental and social solutions; from engineers designing concrete and steel treatment works to regional planners designing and building weather-resilient, green communities; from isolated public service units to integrated members of economically thriving local economies.

This *Blueprint for Action* defines tangible steps—actions we can take as a Nation to realize this vision.



DEFINING THE UTILITY OF THE FUTURE

Evolution of Today's Clean Water Utility

Urban sanitation in the United States has evolved from the 18th century norm of dumping human waste in the streets, through the era of sewage collection but little treatment from the mid-1800s through the early-1900s, to early treatment efforts of the early to mid-1900s, to the Clean Water Act era of federal intervention requiring secondary or greater treatment following the Act's passage in 1972. According to a recent poll of 11,341 readers conducted by the *British Medical Journal*, the advent of modern sanitation—collection and treatment of human wastewater prior to discharge—was the single most important public health advance of the last two centuries.[1]

The institutions that managed this transition have similarly evolved. In the early years, sewer companies were nearly all owned and operated privately. As cities realized that modern sanitation held the key to a healthy population and economic growth, governments stepped in to expand collection networks. City public works departments that added rudimentary treatment to help clean up America's waterways from raw sewage discharge eventually became city sewer departments. Over the first couple of decades following Clean Water Act mandates for both greatly enhanced treatment and increasing financial sophistication, many city sewer agencies transitioned into public, but generally larger, regional, and often independent authorities with broad technical, financial, legal, and management mandates. Not surprisingly, utility leadership diversified to include lawyers, economists, scientists, and management experts as well as engineers.

Today, America's urban clean water agencies are among the most sophisticated and effective utility organizations in the world. They deliver services to more than 90 percent of the U.S. population; their operations affect nearly every river, stream, lake, estuary, and coastal waterway in the United States; they manage more than $500 billion in net depreciated assets; they finance about $25 billion per year in capital investments; they manage a combined budget of more than $55 billion per year.[2] They remove more than 90 percent of organic inputs, an estimated 55 percent of nutrients, and nearly all harmful bacteria.[3] Environmental outcomes are equally impressive—according to EPA and state analyses, municipal wastewater discharges account for less than 10 percent of remaining water quality impairment of the Nation's rivers, streams, lakes, reservoirs, and coastal shoreline and only about 30 percent of impaired estuaries.[4]

The public health and environment-based model of the “traditional” wastewater treatment utility that evolved over the last 150 years has had as its principal objectives: to collect and transport human and industrial wastewater quickly and as far downstream as possible to central treatment works that could purify it sufficiently and cost-effectively so that when discharged, receiving waters would meet applicable environmental standards.

Defining the Utility of the Future: A New Model Is Emerging

While traditional public health and environmental protection will always be central, the model for the utility of the future (UOTF) is evolving in new directions. It contemplates a new business approach where instead of simply collecting, treating, and disposing of municipal and industrial wastewater, the UOTF recognizes that its inputs are valuable resources. As such, its objectives are to separate, extract, reuse, or convert valuable water, energy, and commodities from wastewater while using utility assets in innovative ways to reduce costs, increase revenues, and strengthen the local economy. The UOTF also seeks to engage more fully with others that share the water resource through watershed-based approaches, innovative partnerships, and adaptive management techniques to ensure that actions maximize environmental benefits.

This is no longer an aspiration. With the help of technology developers, innovative clean water agencies are beginning to take these steps today.

A Model of the Wastewater Utility of the Future

Motivation	Activity	Innovation
Financial Strengthening (Increased Revenues, Reduced Costs)	Water Reuse	• Industrial Cooling, Recharge, Landscape, Golf Course Irrigation
	Materials Recovery	• NH_4, P Compounds, N Compounds, Metals
	Materials Conversion	• Bioplastics, Pyrolysis Fuel Oil, Algal Biomass, Solid Fuels, Fertilizers
	Biosolids Reuse	• Liquid/Solid Fertilizer
	Energy Generation	• Photovoltaics, Wind Turbines
	Energy Recovery	• Methane, Hydrogen, Heat Recovery
	Operating Efficiency	• Automation and Smart Operations, Asset Management, Sourcing
Environmental Sustainability	Watershed Processes	• Alternatives to Point Source Controls
	Energy Efficiency	• Energy Efficiency Equipment & Networks
	Green Infrastructure	• Green Roofs, Urban Parks, Porous Pavement, Leak Detection & Repair
	Infiltration/Inflow Control	
Social and Community Well-Being	Growth Planning	• Sectoral Expansion, Targeted Upgrades, Managed Package Plants
	Green Infrastructure	• Urban Runoff Controls
	Infiltration/Inflow Control	• Biowaste Conversion To Methane
	Community Partnering	

The Nation's clean water agencies are becoming more energy and operationally efficient, recovering energy from biosolids, reusing effluent and biosolids, recovering nutrient and other constituents, transforming waste streams into valuable new commodities, taking steps to support economic expansion by setting capital investment priorities to meet the needs of industry, and working collaboratively with other water quality interests within their watersheds.

The Business Case for Action: Why Utilities Are Transforming Themselves

Part of the explanation for why clean water agencies are increasingly taking these actions lies in the natural evolution of the institutions as introduced earlier—after decades of experience, utilities simply have done a good job at meeting traditional objectives. Utilities also realize that for some constituents including nutrients, mercury, and emerging pollutants, the most effective environmental solutions and the most cost-effective solutions for the communities they serve increasingly involve others outside their direct control.

At the same time, communities are reaching the limit of traditional sources of urban water in many areas, especially in the arid West; real costs of energy are rising steadily; and local budgets are stretched thin as utilities cope with political reluctance to raise rates even as costs of asset replacement and advanced treatment are escalating. In some cases, customers have limited ability to pay more for wastewater services. As a result, one of the key drivers is financial. Utilities that undertake transformative measures toward the UOTF, from treatment and disposal of wastewater to sustainable resource management, generate from their own perspective, net benefits in the form of reduced costs and increased revenues.

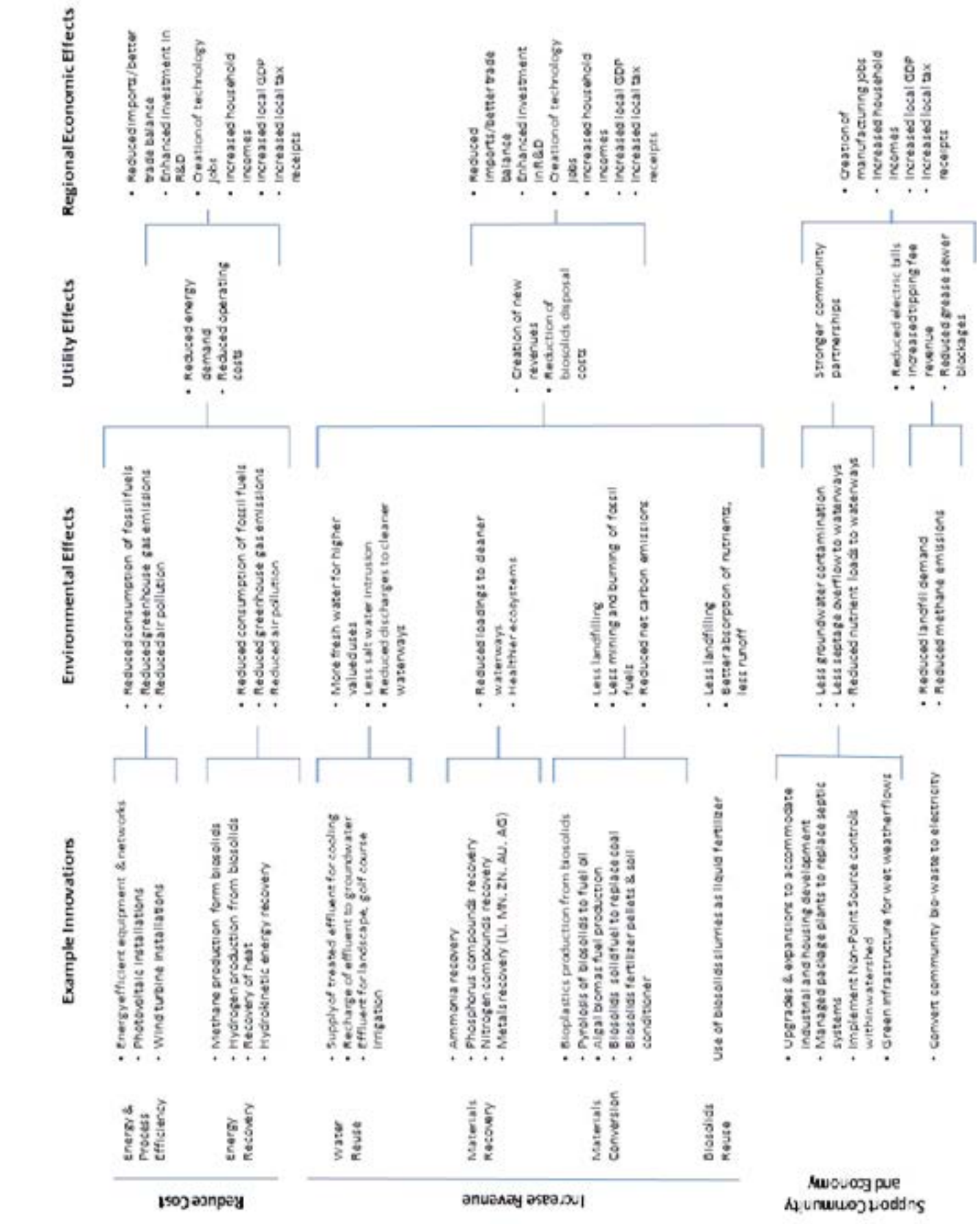
Importantly, these actions also result in benefits to the environment, the communities they serve, and both local and the national economies (see the chart below). Fewer residuals are released into the environment. Those that are released are generally in a more benign form. Many UOTF elements capture methane, a powerful greenhouse gas that would have been released to the atmosphere. Clean water agencies that substitute their own renewable forms of electricity for purchased electricity from carbon-based fuels reduce CO_2 emissions. Utility savings are passed back to the community in the form of mitigated rate increases and investments to strengthen service delivery and environmental quality.

UOTF Leadership in the United States

The Camden County Municipal Utility Authority (CCMUA), which serves 500,000 people across 37 communities in southwestern New Jersey, responded to economic pressures over the last five years with a series of UOTF initiatives including operating performance improvements, green infrastructure, solar energy, and currently underway, methane recovery from biosolids. Combined operating and capital costs are now lower than they were in 1996, effluent is cleaner as are the tributaries to the Delaware River into which CCMUA's effluent is discharged, odors from the plant have been significantly reduced, and vendor-financed solar photovoltaic arrays save about $300,000 per year in energy costs.

The Milwaukee Metropolitan Sewerage District (MMSD), serving 1.1 million customers in 28 communities in the regional Lake Michigan watershed, has set stringent, 25-year sustainability, cost reduction and efficiency goals. MMSD's two guiding principles capture the essence of the UOTF: (1) sustainable bottom line, balancing economic, environmental, operational, and social values; and (2) water quality leadership and collaboration through strategic alliances and a watershed approach.

MMSD promotes future use of green infrastructure, cost-effective, watershed-based permitting and effluent trading, renewable energy sources to meet 100 percent of its energy needs, reduction in its carbon footprint by 90 percent from a 2005 baseline through energy efficiency projects, and multiple steps to mitigate the effects of climate change.


Example Innovations
Environmental Effects
Utility Effects
Regional Economic Effects
Reduce Cost
Increase Revenue
Support Community and Economy
Energy & Process Efficiency
Energy Recovery
Water Reuse
Materials Recovery
Materials Conversion
Biosolids Reuse
• Energy efficient equipment & networks
• Photovoltaic installations
• Wind turbine installations
• Methane production form biosolids
• Hydrogen production from biosolids
• Recovery of heat
• Hydrokinetic energy recovery
• Supply of treated effluent for cooling
• Recharge of effluent to groundwater
• Effluent for landscape, golf course irrigation
• Ammonia recovery
• Phosphorus compounds recovery
• Nitrogen compounds recovery
• Metals recovery (Li, MN, ZN, AU, AG)
• Bioplastics production from biosolids
• Pyrolysis of biosolids to fuel oil
• Algal biomass fuel production
• Biosolids solid fuel to replace coal
• Biosolids fertilizer pellets & soil conditioner
Use of biosolids slurries as liquid fertilizer
• Upgrades & expansions to accommodate industrial and housing development
• Managed package plants to replace septic systems
• Implement Non-Point Source controls within watershed
• Green infrastructure for wet weather flows
• Convert community bio-waste to electricity
• Reduced consumption of fossil fuels
• Reduced greenhouse gas emissions
• Reduced air pollution
• Reduced energy demand
• Reduced operating costs
• Reduced imports/better trade balance
• Enhanced investment in R&D
• Creation of technology jobs
• increased household incomes
• increased local GDP
• increased local tax receipts
• More fresh water for higher value duties
• Less salt water intrusion
• Reduced discharges to cleaner waterways
• Reduced loadings to cleaner waterways
• Healthier ecosystems
• Less landfilling
• Less mining and burning of fossil fuels
• Reduced net carbon emissions
• Less landfilling
• Better absorption of nutrients, less runoff
• Creation of new revenues
• Reduction of biosolids disposal costs
• Less groundwater contamination
• Less septage overflow to waterways
• Reduced nutrient loads to waterways
Stronger community partnerships
• Reduced electric bills
• increase tipping fee revenue
• Reduced grease sewer blockages
• Reduced landfill demand
• Reduced methane emissions
• Creation of manufacturing jobs
• increased household incomes
• increased local GDP
• increased local tax receipts

Local economies and, in many cases, the national economy, also benefits (these effects are illustrated in the Figure). Reduced costs and increased revenues passed back to households and businesses create more disposable income, which can be reinvested in local goods and services. Business will have more capital to reinvest in plants and equipment as well as in research and development. Part of this investment ends up creating new jobs in the technology and manufacturing sectors, which create demand for new housing and other goods. As a result, governments enjoy growing tax receipts. Nationally, energy savings reduce imports and support a healthier balance of trade. Locally, utilities enjoy a dividend from these value dynamics as they come back to the utility in the form of increased demand and higher revenues.

Nonpotable wastewater reuse (for industrial cooling, toilet flushing, landscape irrigation, fire fighting, and ecological enhancement), while still in its infancy, is increasing rapidly and offers cost-effective solutions to stressed regional water supplies in the West and in rapidly growing regions in the Southeast. Water reuse builds on the success of water conservation programs, which have allowed utilities to better manage infrastructure expansion needs. While nonpotable wastewater reuse has doubled over the last decade to about 2 billion gallons a day, this represents only about 5 percent of total municipal wastewater discharged, according to the WaterReuse Association.[5] Where water scarcity threatens local economies or community stability, reuse offers “water independence” and greater local control of future economic growth. Locally generated electricity has similar benefits to communities that depend on fragile generation or transmission infrastructure for their supply.

U.S. clean water agencies are increasingly engaging within their service areas as both public health and economic development leaders. Some activities are routine—coordinating with local and state highway agencies to replace sewer pipes when roads are being rebuilt or with telecommunications companies to lay fiber optic cable to under served areas when sewer lines are open for repair or replacement. Similarly, clean water agencies often work very closely with economic development agencies and real estate developers to furnish new or expanded services to potential entrants. Increasingly, public wastewater authorities are partnering with technology developers and solution providers to develop renewable energy, nutrient recovery, wastewater reuse, and operational efficiency projects. Similarly, clean water utility managers are increasingly taking the lead in watershed-scale management initiatives that address both water quality and water use.

UOTF Leadership in the United States

The East Bay Municipal Utility District (EBMUD) serving Oakland, Calif. and surrounding areas east of San Francisco implemented an innovative program to blend community food waste (e.g. fats, oils, and grease from local restaurants and food waste from wineries and farms) with their own biosolids to produce enough methane-generated electricity to meet their own demand and send excess to the local grid. This 55,000 megawatt-hour/year, $31 million biogas project saves the utility $3 million per year in energy and contributed to EBMUD’s reduction of 13,300 metric tons of carbon from its 2010 baseline.

The Hampton Roads Sanitation District (HRSD), serving 1.6 million people in 17 cities in southeast Virginia, employs a unique nutrient recovery process in its Nansemond Treatment plant, one of nine large treatment facilities. In an innovative partnership with Ostara Nutrient Recovery Technologies, Inc., HRSD recovers and converts about 85 percent of phosphorus and 25 percent of ammonia from its dewatering process into a slow-release fertilizer, Crystal Green™. Fertilizer revenues offset both capital and operating costs, effectively reducing discharge of nutrients at no cost to HRSD and, compared to alternatives, saves ratepayers money. It also increases overall plant efficiency and replaces mined phosphorus fertilizer, generating net economic and environmental gains. Dozens of clean water agencies have installed solar photovoltaic networks and/or erected wind turbines, converting their land and building assets into sources of renewable energy to power their facilities, reduce energy costs, and cut carbon emissions.

A Vision for the Future

While it is clear that America's clean water agencies are emerging in the direction of the UOTF, the pace, depth, and breadth of this transformation remains unclear. As is the case at any fundamental turning point, many believe that we are unable to imagine today the extent to which utilities could eventually innovate if faced with the right supportive conditions.

Discussions of innovation often include elements like the amount and quality of research; adoption rates and risk sharing; cooperation between academic, public, and private institutions; institutional leadership; workforce education; R&D funding and access to venture capital; protection of intellectual property rights; and market forces and competition. Indeed, many of these are relevant to the U.S. clean water sector. In terms of what may be needed to create optimal conditions for innovation, sector leaders can point to many incremental changes within the industry and across the legislative, administrative, financial, and institutional environments in which they operate. Some envision bold new directions for their organizations—new models for highly efficient, community-based delivery of public health, customer service, and technology development.

The UOTF will be more distributed, automated, and circular. Reuse facilities, for example, are likely to be distributed because it will make little economic sense to reuse wastewater after it is transported long distances downstream to centralized facilities and pumped back upstream to points of application. Significant savings in energy, infrastructure replacement, and maintenance are possible with distributed, local reuse for cooling or landscape irrigation. Automation and controls, web-enabled mobile devices, and cloud computing will help drive this transition and, more generally, enable unattended operations linked to central control rooms that monitor operations, adjust processes in real time, communicate with customers, and manage the entire commercial process. UOTF processes will be circular in the sense that water, nutrients, solids, heat, energy, and other constituents will be reused and not discarded.

The UOTF will be greener and more involved with others within its watershed. Greener as a result of energy efficiency and generation of renewable energy, but also greener in terms of the design of facilities and the choices of solutions, especially green infrastructure—natural land-based solutions in place of concrete and steel containment and treatment structures—to manage stormwater. Working with others at the watershed scale will enable clean water agencies to implement water quality solutions that save them and their communities' money while preserving valuable resources for their most productive uses, including for example, partnering with drinking water utilities on conservation to reduce sanitary wastewater and expansion of wastewater infrastructure.

UOTF Transformations Worldwide

Similar transformations are occurring around the world.

Singapore's Public Utility Board has been treating and reusing municipal wastewater to drinking water quality since 2003. With three "NEWater" plants in operation today, reused wastewater supplies 30 percent of Singapore's water needs, including for industrial processing and blending with reservoir supplies for potable reuse. By 2060, Singapore estimates that NEWater will meet 50 percent of the Nation's water needs.

Australia has embarked on a $1.5 billion "Water Smart Australia" program to transform the way utilities and other institutions use and manage their water resources with broader and faster uptake of smart technologies. In one example, two private firms, Veolia Water and AquaNet Sydney acquired the license to supply Sydney Water, the public utility serving Australia's capital, with about 5 million gallons per day (mgd) of recycled water under a 20-year agreement. In this $100 million project, treated secondary wastewater is diverted from discharge pipes and membrane filtered (ultra filtration and reverse osmosis) prior to storage and pumping to various sites for reuse as industrial cooling and process water, as well as irrigation and fighting fire.

Enabling Innovation: What It Will Take to Realize the Vision

Fundamentally, innovation in the clean water sector is already taking place because it's good for the utility, the environment, the community, and the economy. The market is working, but at a slow and unpredictable pace. Left to evolve on its own, one might imagine a future where economic, environmental, and social forces drive a slow and bumpy transition to the UOTF. Relatively modest changes to current conditions would drive this transition more predictably to more locations, large and small, across the Nation.

To effect the transition, utility leadership and management will have to continue, if not escalate their own programs that deliver continuous improvement in operational efficiency. External changes also are needed, however, to enhance incentives and reduce barriers that exist within legislation, regulations, administrative policies and priorities, finance and risk management conventions, and institutional partnerships.

In a 2012 survey of 62 medium and large clean water agencies, "project financing" and "regulatory concerns" were the two most frequently cited barriers to successful implementation of UOTF activities.[6] Technology risks were a close third. Among the least-cited barriers were management reluctance, customer acceptance, and legal authority to take the sorts of UOTF actions described above. A few utilities said availability of land would prevent them from taking certain UOTF actions, such as installing solar photovoltaic farms or wind turbines. The following section explores the most prevalent of these barriers and proposes actions to mitigate them. It also examines ways to provide incentives for technology innovation and broader adoption across the sector.

UOTF Opportunities Available to All Size Utilities

Simple process and equipment changes that cost about $1 million generated about $50,000/year in energy savings in Mukilteo Washington's 2.6 mgd facility.

Less than $15,000 in advanced instrumentation and controls netted more than $9,000 in annual energy savings at the Bartlett Tennessee wastewater plant.

The clean water utility serving Cascade Wisconsin (population: 706) is powered 100 percent with renewable energy from two 100 KW wind turbines, generating $30,000/yr in energy savings (12.5 year payback) and reducing carbon emissions by 200 tons per year.

The 2 mgd clean water utility in Essex Junction Vermont recently installed two 30 kilowatt methane-fueled micro-turbines to generate its own electricity from biosolids. In this combined heat and power (CHP) project, waste heat offsets the cost of fuel needed to heat its anaerobic digesters. With total energy savings of $33,000 per year, the project has a 7.84 percent IRR and reduces CO2 emissions by 30 tons per year.

The Gloversville-Johnstown NY wastewater facility serving 25,000 residents and 12 local industries generates 90 percent of its energy needs in its anaerobic digester processing biosolids from the plant plus local dairy wastes. It saves $500,000 per year in energy costs and nets $750,000 per year in additional revenue from dairy waste acceptance fees.

CREATING AN ENVIRONMENT OF INNOVATION

Today's clean water agencies operate within a complex environment of legal, institutional, and financial forces that, taken together, influence utility decisions. By using these forces to provide the right incentives and remove unnecessary barriers to innovation, the Nation can help utilities be better stewards of the environment and suppliers of public health services. These actions can mitigate risk, strengthen project feasibility, and stimulate technology advancement with minimal resource commitments that generate high rates of economic, environmental, and social return. In short, by reexamining current policies from the perspective of the UOTF, one can further enhance environmental and public health outcomes while enabling emerging objectives like resource recovery, water reuse, energy efficiency, and sustainable communities.

This section suggests key changes to:

- Legislation and regulations,
- Institutional and programmatic practices,
- Financial and risk management conventions, and
- Utility leadership and internal management approaches.

Each of these areas will be explored subsequently in this section. Options and suggestions are drawn largely from the experiences of clean water agency practitioners, technology suppliers, academics, and industry analysts that have participated in this initiative. The intent is to be indicative, not categorical, so options should be taken as examples. This is a long-term transition and requires a long-term commitment at all levels.

Legislative and Regulatory Actions

Among the many factors that will affect the types of UOTF activities that clean water agencies will pursue and why they will pursue them, none will be more important than the regulatory environment. In the same survey mentioned above, eight out of ten clean water agency managers said regulatory inflexibility is "very important" or "the most important" factor that needs to change to create more innovation in the sector.[7]

Key legal or regulatory actions include:

- Watershed-based processes and integrated approaches designed to deliver enhanced water quality outcomes at lower total social costs,
- Elimination of unintended barriers to widespread innovation on utility-scale energy recovery and generation, and
- Integration of water reuse into wider regional water supply solutions while managing public health risks and costs to all water users.

Given the key role that the U.S. Congress will play in helping clean water agencies transition to the UOTF and today's fiscal realities, it seems logical that the industry advocate for a Congressional Caucus on the UOTF *(see page 30 for details)*. Not only would it raise awareness among legislators, but it would elevate the importance of water to society and ensure that the federal government is doing everything it can to support the industry. A Congressional UOTF Caucus also would enable the industry and regulators to interact regularly with federal legislators to sort through the issues and set priorities.

An Alternative to the Traditional TMDL

The Dupage River Salt Creek Workgroup (DRSCW) offers a cost-effective alternative to the more formal TMDL process, which could serve as a model for other watersheds faced with similar challenges. This 360-square mile watershed in northeast Illinois lies in two counties and is home to 55 municipalities, 25 publicly owned treatment works (POTWs) that collectively discharge 15 mgd, 41 permitted MS4 stormwater discharges, and more than 21 dams that have significantly altered the hydrology of its natural waters.

Illinois EPA issued TMDLs for dissolved oxygen and chlorides in 2004, which if applied strictly to reduced effluent loadings at basin point sources, would have cost around $50 million. Instead, municipalities, POTWs, and environmental organizations created DRSCW, a voluntary nonprofit organization to decide how to meet ambient water quality goals. Through water quality monitoring, bioassessment, modeling, and engineering analyses, DRSCW was able to meet dissolved oxygen goals through dam removal and habitat restoration at significant savings. DRSCW is addressing the chloride issue through education on alternative deicing and anti-icing methods.

Watershed-Based Water Quality Solutions. After 40 years of ever-increasing regulatory pressures on U.S. clean water agencies, most of the easy and cost-effective solutions are already in place. Achieving further reductions in pollutant loadings from wastewater treatment plants will be disproportionately expensive relative to potential gains in ambient water quality or relative to the cost of achieving the same or in many cases, far better ambient water quality, by addressing unregulated sources of pollutants or other forms of water quality impairment.[8] This suggests that from a community or broader social perspective, everyone would be better off if the Clean Water Act (CWA) and state equivalents formally encouraged processes that would enable local innovation around least-cost watershed scale water quality solutions rather than less effective, efficient, and equitable solutions because of their enforceability under current law and administrative practice. Following are examples of legislative and regulatory actions that would promote watershed solutions. Continued analysis of these and other watershed matters is needed, however, as more utilities participate in watershed-scale programs.

Total Maximum Daily Load Process. When effluent standards based on conventional wastewater treatment technology under the Clean Water Act are unable to produce ambient water quality that meets criteria for designated uses of the receiving water, the Act provides the states and EPA authority to establish a Total Maximum Daily Load (TMDL) for the pollutants of concern from all sources so that criteria will be met. States then allocate loadings of this pollutant to all point and non-point sources in the watershed. But since only point sources are regulated, the TMDL process must rely on voluntary actions to control non-point sources, which are sometimes subsidized through various state and federal grants. Often, the result is load reductions are

Examples of Successful Trading Programs

One recent program that enables trading of nutrient reductions from all sources across nine states in the Ohio River Basin could serve as a model for other watershed-based trading programs. Launched in 2009, with some states joining as recently as 2012, the project is a first-of-its-kind interstate multicredit trading program. It represents a comprehensive approach to developing markets for nitrogen, phosphorus, and, potentially, greenhouse gas reduction credits. At full scale, it would become the world's largest water quality trading program, potentially creating credit markets for 46 power plants, thousands of wastewater facilities and other industries, and up to 230,000 farmers.

As part of its program to meet nitrogen load reductions to Long Island Sound, the state of Connecticut has established a successful nitrogen credit exchange/trading program. During the period 2002-2009, some $46 million in nitrogen credits were bought and sold, providing a cost-effective alternative for 79 clean water agencies to meet their nitrogen waste load allocations as part of the TMDL adopted for Long Island Sound. Compared to other alternatives, these facilities have saved between $300 and $400 million through trading.

In 2012, the U.S. Department of Agriculture awarded $2.35 million in grants to organizations in the Chesapeake Bay watershed to build the infrastructure needed to support a Bay-wide water quality trading program. This program is expected to reduce loadings of nutrient and other pollutants to the Bay at significant savings to clean water agencies, farmers, and stormwater utilities.

disproportionately allocated to point sources, against which EPA and the states can take legal action, rather than non-point sources to which enforceable regulations do not apply.[9] Because of the uncertainties associated with results from non-point source programs, EPA suggests in its TMDL guidance that it may be necessary to reopen CWA permits and require more stringent limits on point sources in the event that non-point sources are unable to reduce their loadings.

Action: With Congressional authorization as needed, EPA and the states should reform the TMDL process to achieve reliable, least-cost loadings reductions regardless of source and/or other in-stream actions to restore ambient water quality goals, with appropriate financial support where needed, monitoring, and enforcement.

Pollutant Load Trading. Currently, many states enable groups of wastewater treatment utilities within a watershed to work together—that is, trade pollutant loadings among themselves—to attain ambient water quality standards through any combination of loadings that minimizes aggregate costs. Until recently, states did not allow such trading among point and non-point sources, even though in some watersheds, the cost of removing pollutants per unit removed from non-point sources is 10 to 100 times less than point sources.[10] One of the key features of a successful trading program is regulatory flexibility, which enables regulated sources adequate time to attain superior water quality outcomes across all dischargers rather than focus strictly on ways to meet their own ever-increasing permit restrictions.

Action: Congress should support greater adoption of watershed-based solutions by explicitly encouraging trading in the Clean Water Act and extending permit terms for facilities that are participating in these processes. Similarly, EPA should work with delegated states to promote viable and flexible trading programs.

Adaptive Management. The term "adaptive management" in the broadest sense refers to the philosophy of using new information to modify actions within a long term project strategy. The Wisconsin Department of Natural Resources has incorporated the term in a somewhat more narrowly defined manner to describe a regulatory

compliance strategy whereby a permitted point source (or group of point sources) will work toward water quality compliance with a state designated water quality standard by developing partnerships within the watershed to balance load reduction efforts by both point and non-point sources. The intent is to reduce discharges of the parameter of concern to the water body by the most cost-effective method rather than relying strictly on reductions by point sources through installing tertiary treatment. Point-source dischargers are afforded flexibility and can defer or avoid costly infrastructure installation by facilitating load reductions within the agriculture or other non-point sectors. Adaptive management differs from water quality trading in that it doesn't require trade ratios or margins of safety, but does require demonstration of eventual compliance with the ambient water quality criteria in the receiving water. Adaptive management activities often achieve complementary improvements in the watershed in addition to reduction of specific parameters of concern.

Action: EPA should amend its TMDL regulations and guidance to formally incorporate adaptive management as part of the TMDL approach. Until it does, EPA should issue guidance to state regulators that encourages states to pursue these voluntary processes based on the Wisconsin model.

Energy Extraction from Wastewater and Biosolids.

According to recent industry analyses, heat and embedded energy in biosolids extracted by U.S. clean water agencies contain enough energy to meet up to 12 percent of U.S. electricity demand.[11] Aside from the savings in utility energy costs and potentially, revenues from the sale of surplus energy and, carbon credits, energy extraction/conversion at wastewater facilities contributes to energy independence, reduces the community's carbon footprint, and saves ratepayers money. As documented above, some clean water agencies are converting their wastewater solids to energy using anaerobic digesters to produce methane, which is converted to electricity. Others use dry biosolids as a fuel. A promising technology converts biosolids to a combustible gas via pyrolosis. Energy also is recoverable from wastewater itself. Treatment plants, especially in cold climates, use heat exchangers to extract heat from effluent to preheat processes, offsetting energy demand. Promising technologies include solar conversion of nutrients in wastewater effluent to algae for use in biofuels production and use of wastewater fuel cells to capture electricity created when microbes convert compounds

Extracting Energy from Wastewater and Biosolids

San Diego's Point Loma Wastewater Treatment Plant operates a 1,350-kilowatt hydroelectric plant that captures hydrokinetic energy sufficient to power 1,300 homes as its treated effluent drops 90 feet prior to discharge through a 4.5-mile ocean outfall.

Irvine Ranch, California, serving roughly 500,000 people in Orange County, is now installing a biosolids-to-biogas plant, which will save its customers more than $10 million per year for the next 20 years (about $100 per year per customer).

Massachusetts Water Resources Authority, serving 43 communities in greater Boston, generates about a quarter of its energy needs from its own power plant fueled by methane produced in its anaerobic digesters on Deer Island. This process, which also produces hot water used in treatment processes, saves $15 million per year in fuel oil costs and another $2.8 million per year in electricity.

Dried biosolids also can be used as a much cleaner fuel than coal. A cement kiln in Union Bridge, Maryland, uses about 40,000 tons/year of dried biosolids pellets in place of coal. Another kiln in Rialto, California, uses 1,640 wet tons/day of biosolids converted to 300 tons/day of dry biosolids fuel (95 percent solids) with 5,529 Btu/lb in energy value (slightly less than low-grade coal).

Detroit's Water and Sewerage Department is planning to construct a biosolids drying facility by 2016 to produce up to 200 dry tons/day of dried pellets, which may be used as a fuel source in electric power plants in place of coal, helping meet the state's mandate of 10 percent of its power from renewable sources. Dried pellets also may be used as a fertilizer/soil amendment.

of carbon and nitrogen. Following are examples of energy-related legislative and regulatory actions that would provide incentives for clean water authorities to recover energy or eliminate barriers that inhibit some facilities from doing so. Continued analysis of these and other energy-related matters is needed, however, as more utilities take on energy projects.

Expansion and Clarification of Current Energy Tax Credit and Incentive Programs. Some of the existing federal tax credit and incentive programs designed to promote investment in renewable energy did not necessarily contemplate clean water agencies as developers or partners with private developers. Included here are such programs as the renewable fuel standard, renewable energy production tax credit, clean renewable energy bonds, and qualified energy conservation bonds. As the Nation moves toward energy independence through, for example, development of renewable energy standards, the wastewater community needs to be part of the conversation to ensure that the energy they generate is included.

> ***Action: The clean water sector should work with Congress to examine these programs to ensure that they do not exclude or limit their participation, and, where it does or can, they should work with Congress to amend authorizing language to ensure that private investors have every incentive to partner with clean water authorities to extract energy from wastewater and biosolids and ensure that renewable energy from these facilities, however generated, is eligible to participate in markets for renewable energy.***

Multimedia Benefit and Risk Frameworks to Resolve Regulatory Conflicts that Inhibit Energy Recovery at Clean Water Authorities. As America's clean water authorities innovate around energy recovery, conflicts will inevitably arise between energy recovery and other objectives. These can be resolved using multimedia risk and benefit analyses. In March 2011, for example, EPA finalized new source performance standards and emission guidelines for new and existing sewage sludge incinerators intended to reduce emissions of nine pollutants from these facilities.[12] This rule is currently the subject of litigation. According to the wastewater industry, these rules will make it prohibitively expensive for clean water agencies to invest in innovative biosolids incineration/energy production technologies. It is questionable whether the modest potential reduction in public health risk from this proposed rule exceeds the risks associated with the alternative of landfilling biosolids. Where these incinerators are used to recover energy, additional environmental and public health returns in the form of reduced fossil fuel use and reduced carbon and methane emissions should exceed any gains from the proposed rule.

> ***Action: EPA should revise the March 2011 sewage sludge incineration rule to exclude sewage sludge incinerators that use biosolids to generate energy. More broadly, EPA should work with clean water authorities to formulate procedures that account for multimedia assessment of energy and resource recovery alternatives at their facilities, so that future rules can take a broader, more holistic perspective of all environmental benefits and risks.***

Relief from Limits on Tax-Exempt Bonds Used to Finance Publicly Owned Renewable Energy Projects. Under section 141 of the Internal Revenue Code, public clean water agencies cannot issue tax-exempt bonds to finance energy recovery or energy production projects if more than 10 percent of the energy produced is sold to private users, including, generally, feeding unused electricity back to the grid.[13] This rule can affect projects

that recover methane from wastewater solids, create electricity by burning biosolids fuels, recover municipal landfill methane to produce electricity, or use utility land to generate electricity from photovoltaics or wind-powered generators. In place of low-cost tax-exempt bonds, utilities faced with this rule can reduce output of their project to meet their own needs, use higher-cost private activity bonds or taxable bonds, or partner with an energy service company who finances the project. All of these alternatives either limit energy recovery potential and/or increase costs.

Action: Congress should relax the private-use test for publicly owned and operated energy recovery or production projects as long as the issuer first satisfies 100 percent of its own energy needs before selling excess production.

Including Combined Heat and Power (CHP) Projects at Clean Water Agencies in State Renewable Portfolio Standards (RPS). Many state RPSs require that a specified percentage (typically 10 to 30 percent) of energy produced within the state comes from renewable energy sources. As of October 2012, 37 states and the District of Columbia had established RPS requirements or goals. But only 28 of these states included biogas from the anaerobic digestion of wastewater solids or waste heat recovery, as an eligible resource.[14] RPSs stimulate market and technology development for renewable energy. If states do not include biogas (methane), synthetic gas (other carbon-based combustible fuels), and heat recovery, which include nearly all of the methane recovery/electricity generation projects at wastewater treatment plants as an eligible resource—energy solution providers and energy users lose valuable incentives to invest in or buy power from these sources.

Action: State legislatures should amend their RPS eligibilities to include energy recovery projects from biosolids. To help legislatures understand why such changes would generate triple bottom-line benefits, the wastewater industry should educate state legislatures on this matter.

Water Reuse. Most federal and state water use and water quality legislation was written and implemented decades ago, before water reuse was widely practiced. As a result, these statutes and the regulations pursuant to them could be easily clarified to encourage more reuse where it can be shown to be valuable, cost-effective, and safe. In its recent study of water reuse, the National Academy of Science noted several instances where legislative or regulatory initiatives would result in such outcomes.[15] Continued analysis of these and other reuse matters is needed, however, as more utilities take on reuse projects.

Water Rights. According to the National Academy report, state legislation that governs creation and allocation of water rights to users generally was not written contemplating reuse of wastewater.[16] Many states have not yet addressed this matter and conventions vary widely among the states that have amended their water laws to accommodate reclaimed water. Generally, it remains unclear whether reclaimed wastewater creates a new supply or a right to use it or if it does, to whom this right belongs, especially where downstream uses, including the environment could be disadvantaged. In some states, utilities have explicit, but limited, rights to reuse water, as is the case in Colorado, where water reuse is limited to the amount imported from outside the basin or that originated as groundwater. In Utah and New Mexico, utilities essentially must have or buy water rights before they can reuse wastewater. Legislation in other states, like Florida and New Jersey, explicitly encourages and promotes reuse of wastewater.

Action: States should clarify use rights associated with, and rules governing groundwater storage of, reclaimed wastewater so that private developers and public agencies would have stronger incentives to engage in nonpotable reuse of wastewater.

SRF Priorities to Include Water Reuse. Under the Clean Water Act, states have wide latitude to set priorities for funding projects using State Revolving Fund (SRF) monies. States facing strong demand and limited natural supplies for water could stimulate local consideration of reuse by driving more SRF funds to these projects through, for example, explicitly recognizing wastewater recycling and reuse as an eligible category for funding; working with SRF borrowers to structure SRF applications that meet other state requirements for funding; and taking other actions that promote needed and feasible wastewater reuse projects.

Action: States in which additional water reuse would help meet future demand for water supplies safely and at least cost should amend SRF eligibilities to include wastewater reuse.

Public Health Protection. Recent risk assessments have shown that properly designed and operated indirect potable wastewater reuse presents public health risks that are orders of magnitude lower than so-called "de-facto" reuse, which already occurs in many places today where public water supplies are drawn from water-ways into which treated municipal wastewater is discharged upstream.[17] These sorts risk comparisons are part of the solution to public acceptance of water reuse, but water utility boards are still reluctant to propose, and the public is still reluctant to accept, direct potable reuse.[18] United States experience with de-facto reuse across major river systems, plus the experience of Singapore *(see side bar on page 9),* suggests that at least some forms of potable reuse can be designed to be safe.

Action: Consistent with the findings of the National Academy in its recent study on water reuse, Congress should amend the Safe Drinking Water Act to make explicit certain safeguards (e.g., advanced treatment, increased monitoring) that are needed to ensure that potable reuse can indeed be safe.

Statutory Acknowledgment of Water Reuse. Regulatory frameworks, most notably the Safe Drinking Water Act and Clean Water Act, fail to address adequately the important role that recycled water supplies can play in terms of public health and safety or sustainable water quality improvement.

Action: Congress should consider three amendments to the Clean Water Act to acknowledge water recycling and reuse where it is feasible and desirable locally: 1) redefine a clean water agency to identify its ability to be a resource provider; 2) extend permit terms for projects that employ resource recovery activities such as water recycling; and 3) name water reuse as eligible for federal financial assistance.

Executive Order on Water Reuse. Currently, at least nine federal agencies play some role in water reuse.[19] By working more closely together, these federal agencies can improve results of their programs and perhaps eliminate duplication. Local clean water agencies and technology developers also would benefit. An Executive Order on water reuse could help coordinate federal reuse policies and programs and stimulate innovation.

Action: The President of the United States should consider issuing an Executive Order that (a) creates a Federal Interagency Task Force on Water Reuse to coordinate all federal water reuse initiatives, and (b) sets a goal for minimum percentages of reclaimed water for all new federal installations (similar to the federal goal for recycled paper).

Institutional and Programmatic Actions

In many cases, simply changing program priorities or administrative processes can drive innovation and help clean water agencies implement effective and efficient UOTF activities.

Options include:

- Acknowledging and paying for stormwater as part of a broader integrated water management approach;
- Leveraging green infrastructure to transform urban environments; and
- Integrated water resources decision making and management .

Leveraging Green Infrastructure to Transform Urban Spaces

Green infrastructure (and reduction of infiltration and inflow to collection systems) offers cities innovative ways to reduce stormwater flows to treatment facilities and polluted runoff to water bodies. Some cities are taking green infrastructure beyond water quality by embedding it within broader initiatives to restructure ways to use urban lands and the way people live, work, and play in urban environments. Significant opportunities exist in vacant lots, roofs, roads, bridges, corridors, medians, parking lots, and other paved spaces for green approaches to stormwater management.

Cities like Washington, D.C.; Portland, Ore.; Syracuse N.Y.; New York City; and Philadelphia Pa.; are taking such steps today. Under a $2 billion agreement signed in 2012 between the two parties, for example, EPA will provide technical support and monitoring, including school gardens and low-income neighborhood revitalization through green design in partnership with Philadelphia on the City's 25-year "Green City, Clean Waters" plan, which aims to protect and enhance urban watersheds by managing stormwater with green infrastructure techniques.

DC Water's new "Clean Rivers, Green District" partnership with Washington, D.C., uses green infrastructure to prevent pollution from coming into contact with rainwater in the first place, while also providing public health, livability, and economic benefits for the District and its residents.

The New York City Green Infrastructure Plan predicts that "every fully vegetated acre of green infrastructure would provide total annual benefits of $8,522 in reduced energy demand, $166 in reduced CO_2 emissions, $1,044 in improved air quality, and $4,725 in increased property value."

Next-generation stormwater utilities can replicate and extend this concept more broadly by partnering with urban planning agencies, architecture and planning faculty at local universities, and experts from across the industry and related professions that have pioneered and demonstrated these concepts.

EPA supports these approaches with a variety of grants as do many other federal and state programs, including the federal and state Departments of Transportation.

Acknowledging and Paying for Stormwater as Part of Integrated Water Management. Municipal separate storm sewer systems (MS4s) are required to develop and implement stormwater management programs to reduce contamination of stormwater runoff within their jurisdictions. According to the most recent analysis, the United States will have to spend some $42 billion over the next 20 years to comply with requirements.[20] Many urban stormwater control authorities have designed equitable and efficient ways to finance their programs, including user fees based on land-owners' proportion of impervious surface within the watershed. A growing number of lawsuits by ratepayers, however, are challenging new stormwater fee programs, arguing that impervious-based charges for stormwater represent an illegal tax. Other complications include legal challenges to stormwater programs that require on site retention of stormwater, a low-cost and green approach, arguing that they constitute illegal local land-use controls. Utility leadership can help avoid costly legal challenges that can delay implementation by educating the public about the long-run benefits of effective, efficient, and equitable stormwater management programs such as least life-cycle costs to ratepayers, distribution of costs in proportion to source of runoff, preservation of open space, and creation of habitat.

Action: Using materials that they have already developed, EPA should support local stormwater management entities in initiatives designed to educate the public about the value of, and equitable ways to pay for, stormwater management as one component of integrated management plans for all water resources within local watersheds.

Integrated Water Resources Decision Making and Management. The transition to the UOTF will be much more effective and efficient to the extent that clean water agencies make joint decisions with other water management and regional planning interests within their service areas. The complication is that in nearly all watersheds, responsibility for these decisions is highly fragmented into multiple public and private entities. Even modest changes in the institutional structure of these entities could have profound results in terms of planning for and allocation of water from all sources to all uses according to availability, cost, and quality. One recent water industry examination of integrated water management called for federal guidance on a "one water" policy from the President's Council on Environmental Quality, better coordination or consolidation of the many federal water programs, and creation and funding of a national water census.[21]

There should be no doubt that these initiatives would have positive outcomes. But, as all analyses rightly point out, sustainable solutions are likely to come as much from the bottom up as from the top down—from those that allocate, regulate, use, price, and pay for water in all its forms (drinking, wastewater, stormwater, etc.). In the short run, clean water utility leadership can organize the many entities that use water or affect its quality within their watershed.

Action: Regional governments should consider creating joint water-wastewater-stormwater utilities that can manage all water within their jurisdictional boundaries as a single resource. Further, these unified water management enterprises would be better equipped to coordinate more effectively with land-use, transport, housing, energy, and other local authorities that use or affect water.

Financial and Risk Management Actions

As regulations and their compliance costs increase and aging infrastructure needs to be replaced, competition for available funds will remain one of the top barriers to more widespread adoption of UOTF initiatives. Ultimately, most UOTF initiatives will reduce future costs or raise additional revenues, so part of the funding solution lies in utility leadership and communication to the public about their own transition and the future of the community under a traditional path versus the UOTF. But many of the benefits of the UOTF approach accrue far beyond community boundaries, for example, to cities downstream that enjoy cleaner waterways and safer water supplies. Benefits accrue to the Nation as a whole through energy independence, reduced greenhouse gas emissions, creation of green jobs, and a stronger economy.

The business case for the UOTF, therefore, argues strongly in favor of a blended approach to funding that draws on local as well as national sources, both public and private. Such an approach would rely on existing grant and loan programs as well as the public capital markets to provide project financing. It also would draw on more innovative partnerships with private solution providers like energy service companies and technology developers that share risks and rewards with public wastewater entities through, for example, performance contacting.

Most forms of long-term funding for infrastructure replacement do a good job of reducing risks associated with failure of assets that could wear out. They are generally are less effective in reducing risks associated with performance of new and innovative technologies that promise to improve performance and/or reduce total life-cycle costs. Many suggest that adoption rates for new technology within the municipal clean water sector are too slow to compel serious investment in technology innovation and, in turn, this limit gains in productivity of invested capital.[22]

Federal Grant Programs That Support UOTF Initiatives

U.S. Department of the Interior, Bureau of Reclamation. Title XVI provides 25 percent matching grants up to $20 million to design and construct demonstration and permanent water reclamation and reuse facilities in the 17 continental United States and to conduct research on reclamation and desalting of impaired surface and groundwater.

U.S. Department of Energy. Energy Efficiency Block Grants to cities, counties, and states to implement energy efficiency projects and programs as well as State Energy Program grants that provide states willing to match at 20 percent grants to fund energy efficiency and renewable energy programs, including establishment of revolving loan funds to finance local projects.

U.S. Environmental Protection Agency. Clean Water and Drinking Water State Revolving Fund capitalization grants to states that fund capital investments to comply with the Clean Water Act and Safe Drinking Water Act, respectively, and separately, a Green Infrastructure Program that provides technical assistance to communities pursuing green infrastructure solutions to comply with stormwater requirements.

U.S. Department of Agriculture. Rural Utility Service financial assistance to towns with populations less than 10,000 for wastewater and stormwater facilities. Rural Development loans and guarantees to build bio-refineries. Natural Resource Conservation Service and Farm Service Agency for conservation objectives, including nutrient controls.

Options include:

- Focusing expanded federal grants programs on UOTF initiatives;
- Early-stage technology innovation grants: ARPA-W;
- Strategies to reduce risk of technology adoption; and
- Financial incentives to reclaim and reuse wastewater.

Focus Federal Grant Programs on Implementation of UOTF Initiatives. At least four federal agencies support grant programs that have helped or could help clean water agencies plan and implement UOTF actions: the U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy (DOE), the U.S. Department of Agriculture, and the U.S. Bureau of Reclamation (USBR) within the U.S. Department of the Interior.[23] These programs could focus greater attention on implementation of UOTF activities (research and development will be discussed in a subsequent section). Clean water agencies contemplating UOTF actions should familiarize themselves with these programs and participate in them as appropriate.

Bureau of Reclamation. Launched in 1992 (Public Law 102-575), the USBR's Title XVI program authorized the Department of the Interior to design and construct demonstration and permanent facilities to reclaim and reuse wastewater in the 17 western states. As of November 2010, approximately $531 million has been appropriated for 42 of the 53 authorized Title XVI projects. The program has generally provided cost sharing for up to 25 percent of the total project costs, with a project maximum of $20 million. As of the end of 2010, the program had a $630 million backlog for projects awaiting appropriations, up from the $354 million backlog in 2006.

> ***Action: The Bureau should focus federal grants on reuse projects, without which returns would be insufficient to attract private co-investment and where they deliver high net economic and social benefits.***

Department of Energy. Among the many renewable energy incentive programs that DOE administers, the Energy Efficiency and Conservation Block Grant (EECBG) and State Energy Program (SEP) grants are perhaps best suited to support UOTF projects at clean water agencies.[24] EECBG, passed in 2007 and first funded in 2009, provided formula block and competitive grants to cities, counties, states, and Indian tribes to implement energy efficiency projects and programs. SEP provides grants to states that match them at 20 percent to implement a wide variety of energy efficiency and renewable energy programs and projects. About 95 percent of the $6.3 billion funds appropriated to these two programs under the 2009 American Recovery and Reinvestment Act (ARRA) are obligated to existing activities, some of which benefitted clean water agencies directly, including EECBG funds that helped finance a new power plant in Miami-Dade County, Florida, that burns methane recovered from the local clean water agency and local landfill.

> ***Actions: (1) Clean water agencies should take advantage of any unobligated grant funds and, to the extent they are eligible, loans from the 29 states that established revolving loan funds using SEP grants[25], (2) On the basis of strong performance of the 2009 ARRA funding, the community should advocate for continued funding under these programs, with explicit acknowledgment that clean water agencies should be priority recipients of funding assistance.***

Environmental Protection Agency. The largest sources of loans and limited grants available to utilities for UOTF initiatives are the 50 EPA grant-funded State Revolving Funds. Given their key role, there should be no doubt that continued funding of these institutions is critical.[26] In addition, EPA's Green Infrastructure Program is providing technical assistance to 27 community partnerships (10 in 2011 and 27 in 2012) to support their efforts to implement green infrastructure solutions to stormwater problems.[27] Assistance (e.g., public charrettes, tactical team assistance, and information sharing on financing) responds to needs, but does not include grants or loans. The value of this assistance is generally small ($35,000 to $75,000) and focused on specific products like code reviews, conceptual designs and strategies for green infrastructure approaches, selection of green

infrastructure elements, modeling the performance of green infrastructure, or evaluating costs and benefits. While small, recipients often use this assistance strategically to meet specific scientific or research needs, to motivate broad participation across their communities, and to engage regulators on matters of affordability and compliance scheduling. An October 2011 joint statement from EPA's Office of Water and Office of Enforcement not only endorsed green infrastructure as part of integrated watershed planning, but noted that EPA and the states have "flexibility to evaluate a municipality's financial capability … and to set appropriate compliance schedules." Clean water agencies, especially those that have stormwater management responsibility, are typically participants of these community partnerships.

Action: The clean water community should advocate for a continuation, if not an expansion of, these EPA programs. Continued federal funding not only preserves the intergovernmental partnership embedded within the Clean Water Act, but it creates jobs and accounts for the "public goods" benefits that all clean water utilities deliver when they ship cleaner water to downstream users; reduces greenhouse gas emissions through energy efficiency, methane reduction, and renewable energy production; and reduces runoff through green infrastructure.

Department of Agriculture. The USDA administers several grant programs that can help utilities achieve their UOTF goals. The Rural Utility Service provides loans, loan guarantees, and grants for wastewater and stormwater systems to towns with populations of up to 10,000. USDA Rural Development provides loan guarantees to rural communities to build or retrofit commercial scale "bio-refineries," which includes biosolids as an eligible feedstock. Its Repowering Assistance Program provides 50 percent grants to producers and sellers of advanced biofuels, including biogas (methane) derived from wastewater biosolids. A sister program provides annual production subsidies to bio-refineries that scale up production year-on-year. USDA administers multiple voluntary programs accompanied by some $2 billion to $3 billion per year in federal subsidies largely through its Natural Resources Conservation Service and Farm Service Agency to achieve a wide variety of conservation objectives. Fundamentally, these programs are designed to reduce soil erosion and wetlands loss, protect habitat, and improve farm productivity. But about 10 to 15 percent is used to control nutrient runoff and these funds could be used more widely to meet watershed nutrient loadings limits at significantly less cost than removing the same nutrient loadings at wastewater treatment facilities located within the same watershed.[28]

Action: USDA should take steps to ensure that a greater proportion of their conservation program assistance funds nutrient reduction programs.

ARPA-W: Early Stage Technology Innovation Grants. Because clean water agencies are responsible for environmental and public health protection, they tend to be justifiably risk averse. One result of this conservative stance, however, is slow adoption of new technology. Despite the substantial size of municipal clean water equipment and services markets, slow adoption of new technology dampens enthusiasm on the part of technology developers and entrepreneurs, artificially reducing the pace of innovation.

To help remedy this, the clean water sector could draw on successful programs in other sectors, like defense and energy, that have created early stage research and development grants to stimulate creation of breakthrough technologies. In the defense sector, the Defense Advanced Research Projects Agency (DARPA) manages numerous grant programs to stimulate innovative research and development initiatives for weapons,

information/communications, electronics, and materials. Modeled after DARPA, the Department of Energy administers its Advanced Research Projects Agency for Energy (ARPA-E), an R&D grants program to "focus on creative, 'out-of-the-box' transformational energy research that industry by itself cannot or will not support due to its high risk but where success would provide dramatic benefits for the Nation."[29] These programs have generated significant technological advances for their intended industries, spin off applications in many other industries, and strong export markets for American technology.

> ***Action: Congress should establish and fund an ARPA-W to work with industry to define high-risk, high-reward R&D needs, solicit proposals from public and private enterprises that have solutions at various stages of commercialization, and manage information flow about research for the benefit of the industry and the Nation.***

Pooled Risk Sharing Strategies. Clean water agencies are slow adopters of new technology in part because of environmental and public health risks if new technologies fail to perform and in part because of the economic, political, and regulatory consequences of failure. Two new initiatives are addressing part of the slow adoption problem. First, the Water Environment Federation and the Water Environment Research Foundation have joined together in a new Leaders Innovation Forum for Technology (LiFT) Technology Evaluation Program (TEP) to facilitate collaboration among facilities for the evaluation and testing of new technologies and disseminate peer reviewed information about emerging technologies.[30] Second, a consortium of U.S. drinking water and clean water agencies are structuring an Innovation Technology Advancement Group (iTAG) with a U.K. technology innovation consultancy to share experiences on new technologies.[31] These could be powerful steps that enhance market pull for new technologies.

But three aspects of adoption risk will remain: (1) abating private development risk and long adoption cycles, (2) simplifying state regulatory approval processes for new technologies, and (3) acknowledging acceptable variability in performance of advanced technologies in new permits.

Risk Abatement Facility within ARPA-W. At least one part of any new program like the ARPA-W proposal above would have to address adoption risk.

> ***Action: Congress should establish within ARPA-W a special development facility for consortia of clean water agencies, universities/research centers, and technology developers, that would jointly apply for federally subsidized private insurance which would offset utility costs in the event that piloting innovative technologies was unsuccessful. This facility also could provide tax credits to private corporations that partnered with a grant recipient to help offset risks associated with developing and commercializing its technology.***

State Certification Reciprocity. State water quality regulators operate largely independently of each other when it comes to approval of new technology to meet permit conditions. The result is that design engineers are reluctant to include new technologies for a proposed project unless they have been demonstrated to work in that state and at that scale, even though the exact same technology may have performed according to spec in an identical application in another state or country. This is a strong disincentive for technology developers and investors in innovative technology. Yet, there are numerous situations wherein states reciprocate to avoid just

this sort of problem: automobile and other vehicle licenses, concealed handgun permits, teacher certifications, online education certification, and pesticide licensing procedures (in the 11 northeast states).

> ***Action: An appropriate organization of the 50 states, such as the Council of State Governments, should formulate a program of reciprocal technology certification, where once tested and permitted in one state, the burden of proof to deny a permit for that technology in any other state falls to the regulatory agency based on guidelines agreed to by all 50 states.***

Acknowledging Acceptable Performance Variability in New Permits. Reliability of some advanced technologies like biological nutrient reduction (BNR) can vary widely from plant to plant, depending on design and actual flows, wet weather events, seasonality, and even diurnal changes in loadings. To reduce regulatory risks, design engineers have attempted to accommodate as many (or all) of these variables as possible. The results is over design (e.g., blowers that are too big, reactor basins that are too large, over-sized pumps) targeted to meeting excessively high performance reliability, high initial costs, and expensive and complex operations. To help fix this, engineers have developed sophisticated process models that more accurately predict plant performance, enabling more appropriately sized facilities that are less expensive and easier to operate. If permits reflected variable performance at levels that were still protective of the environment, engineers would design more appropriate facilities, and costs of advanced processes would be reduced.

Why are Clean Water Agencies Typically Slow to Adopt New Technology?

Not all clean water agencies behave this way, but broadly, they accept new technology very slowly, which dampens innovation. Here's why:

Regulations—clean water agencies have navigated the past 40 years of rules, permits, enforcement actions, and penalties by choosing technologies that are 100 percent proven. New technologies must have a large cost savings to offset risks of deviating from traditional choices.

Management Capacity—clean water agencies are highly capital- and asset-intensive enterprises that manage large work forces over broad geographies, with state, federal and local governing body oversight at the front and thousands of customers to satisfy at the end of their value chains. Many simply have little spare capacity to manage new technology.

Reward Systems Favor the Status Quo—few clean water agencies reward management for taking risks; often the opposite is true. Consequently, decisions tend to maintain the status quo.

Asymmetry in Public Visibility—when clean water agencies perform well, services are typically taken for granted and the public tends to forget that clean water agencies exist. Their failures, however, are generally highly covered by the media and in full public view. The upside of new technology must be substantial, therefore, to overcome the regret and real consequences of technology failure.

The UOTF Paradigm is Still New—clean water agencies are still used to cleaning waste and discharging residuals. The UOTF will change the paradigm to resource management. Until then, new technologies will have to be "pushed" into the sector. UOTFs will create new demand, "pulling" technology through the industry.

Procurement Requirements for Competition—because of their public heritage, many clean water agencies cannot negotiate with a single technology provider, even if the technology cannot be provided by anyone else.

Action: By working more closely with the design engineering community to understand new stochastic approaches to performance and design of advanced technologies including BNR, state and federal permit writers can incorporate results into new permits to ensure that they have more realistic parameter limits that are still protective of the environment but achievable at more appropriate costs.

Financial Incentives to Reclaim and Reuse Wastewater. In some parts of the country, wastewater recycling and reuse can be effective and efficient as a solution to water scarcity. According to the National Research Council of the National Academy of Science:

> "Approximately 12 billion gallons of municipal wastewater effluent is discharged each day to an ocean or estuary out of the 32 billion gallons per day discharged nationwide. Reusing these coastal discharges would directly augment available water resources (equivalent to 6 percent of the estimated total U.S. water use or 27 percent of public supply)."[32]

In a recent survey of 1,000 U.S. consumers, more than 80 percent said they favored the use of recycled water for nonpotable uses such as irrigation, industrial cooling, and toilet flushing.[33] But the cost of recycling wastewater for these uses can be a significant barrier to more widespread adoption. Reuse production costs vary considerably depending on factors such as quality needed, technology, scale, pumping and energy costs, and financing costs. Recent estimates range from $1.83/1,000 gallons for nonpotable reuse, which is roughly comparable to costs of water produced from fresh water supply to $19.44/1,000 gallons.[34] In the same survey, nearly half of respondents said they were willing to pay on average 12.4 percent more on their water bills immediately to ensure that future generations would be less vulnerable to water shortages. So while higher water rates today will be part of the solution, other measures may be needed to fill the gap. Moreover, the gap between reuse costs and other alternatives as above addresses only financial costs. There are significant economic savings associated with wastewater reuse that are not accounted for in strict financial comparisons: reduction in seasonal peak demands on potable systems, which reduces overall capital and operating costs; improved reliability during drought and business investment based on that reliability; and environmental benefits such as preserved in-stream flows, reduced energy demands and lower carbon emissions.

Action: To help fill the relative cost gap and generate other economic and environmental benefits of wastewater reuse, the wastewater industry should advocate for wastewater reuse investment tax credits to attract private investment, expanded grants to cover costs of facility feasibility studies, and/or loan guarantees for reuse projects that serve rural or low-income communities that could not afford to repay market rates.

Utility Leadership and Internal Management Actions

As it matured over the last several decades, the clean water sector has embraced the concept of continuous quality improvement in many forms. But despite these improvements, the industry faces a fiscal crunch today unlike any in its history. Federal funding in absolute and real terms has declined by 90 percent from about $15 billion per year in the 1980s to about $1.5 billion per year in 2012 (all in 2009 dollars). Over this same period, real local investment in wastewater more than doubled from about $27 billion per year to $55 billion per year.

Estimates of total sector capital investment needed to meet national clean water goals also has grown from $155 billion in 1986 to $298 billion in 2008, despite a combined federal/state/local investment in wastewater infrastructure of $750 billion during this period. In many places, combined costs of infrastructure replacement and compliance with environmental regulations greatly exceed both current investment levels and, based on standard metrics, affordability for large portions of local populations. Fiscal pressures alone compel leadership and management in the clean water sector to make hard choices every day with limited resources.

While this *Blueprint* is not intended to provide detailed industry guidance, it is important to acknowledge that future successes depend to a great extent on utilities' initiatives to manage themselves and operate as efficiently as possible. Building on 2007 recommendations from leadership in the drinking water and clean water sector, EPA, NACWA, WEF, and other industry associations published a statement of support for an overall utility management framework based on a series of *Attributes of Effectively Managed Utilities and Keys to Management Success*.[35] This document acknowledged and, to a degree, codified that business in this sector needed to be done in a different way. In 2008, these organizations published the *Effective Utiity Management Primer for Water and Wastewater Utilities*, which reaffirmed the industry's commitment to "effective utility management" or EUM, as a way to assess utility strengths and weaknesses, set institutional priorities, and decide on outcomes they wished to achieve.[36] This collaboration between regulatory and clean water agencies is encouraging as a foundation for further progress.

Other tools and initiatives that are consistent with EUM can help utilities achieve continuous improvement in the productivity of their organizations and help set environmental and public health priorities in a resource constrained world:

- Lean Operations/Six Sigma for continuous improvement;
- Environmental management systems to set priorities;
- Nationally consistent operator training and certification;
- Environmental education; and
- Smart technology to improve service and customer care.

Six Sigma Results

Clean Water Services, a water resources management utility serving 536,000 customers in Washington County, Oregon, escalated its productivity improvement program developed in the early 1990s to Lean/Six Sigma in 1996, with the following results:

- A 24 percent gain in productivity in three years;
- A goal-share program to support collaborative improvement efforts;
- A pay-for-performance system within a collective bargaining agreement;
- The Nation's first integrated, municipal watershed-based permit;
- A partnership with Ostara Nutrient Recovery Systems, to provide the Nation's first full-scale commercial phosphorus recovery system;
- Formation of the Clean Water Institute to commercialize its intellectual property; and
- A Business Process Management Center of Excellence, with core staff trained on Lean and Six Sigma methods.

Over the last decade, Clean Water Services has saved nearly $100 million in operating costs despite their advanced treatment levels. They saved an additional $140 million by instituting the Nation's first temperature water quality trading program. They increased labor productivity by more than 35 percent. The utility's fleet was reorganized enabling a 33 percent reduction in vehicle count. During this period, the utility made strong steps toward the UOTF by reorienting its vision and focus from engineering excellence to watershed and public health stewardship, attaining 100 percent compliance with all permit terms at all four wastewater treatment plants.

EMSs & Other Management Tools

The Lawrence, Kansas, water and clean water utility serving 90,000 customers implemented a utility-wide EMS in 2007. As a result, it reduced biosolids transportation and land application fuel use by 13.5 percent, eliminated drinking water taste and odor problems, sited a new 530 acre wastewater treatment plant, achieved 73 percent customer satisfaction, and reduced workers compensation liability by more than 20 percent in three years.

The Camden County, New Jersey, Municipal Utilities Authority (CCMUA) used an EMS process to address its discharge and biosolids issues with equally impressive results. Prior to its EMS, CCMUA was barely meeting its state discharge permit, being fined and sued for almost continuous odor problems and had recently raised its user rates by over 22 percent. Through the EMS, the CCMUA identified its core objectives to be: (1) optimization of water quality, (2) minimization of odors, and (3) cost efficiency. Within five years of implementing an EMS, the CCMUA improved solids capture by 40 percent, virtually eliminated its odor problems, completely overhauled its physical plant, and reduced suspended solids in its discharge from 26 to 7 parts per million (permit limit of 30 ppm). The utility accomplished all of this while reducing rates from $337/household in 1996 to $324/household in 2012.

Global Water Resources, which operates a portfolio of small and medium drinking water and clean water agencies in Arizona, is perhaps the most technologically sophisticated utility in the United States. It has taken utility efficiency to a new level using evaluation and productivity improvement processes (total water management) similar to Lean, advanced metering infrastructure, and cloud-based data analytics and presentation technology to reduce water losses and put real-time monitoring of water use in the hands of their clients.

Lean Operations/Six Sigma for Continuous Improvement.

Lean operations or simply, "Lean" is a business improvement approach designed to eliminate non-value adding activity or waste using methods developed for manufacturing industries including automotive. Practitioners often combine Lean methods with Six Sigma tools, developed by Motorola and embraced by GE, that use statistical analysis to eliminate defects and variation. Lean and Six Sigma are widely used across the industrial sectors to identify and drive productivity gains through organizational, business process, and technological change.[37] Clean water agencies that use Lean/Six Sigma save millions of dollars, improve service quality, build a confident and motivated workforce, and reduce environmental and safety risks.[38] Its culture of continuous improvement through employee engagement essentially retrains the workforce to think about productivity, take actions to improve productivity, and be rewarded for their successes.

Nationally Consistent Operator Training and Certification.

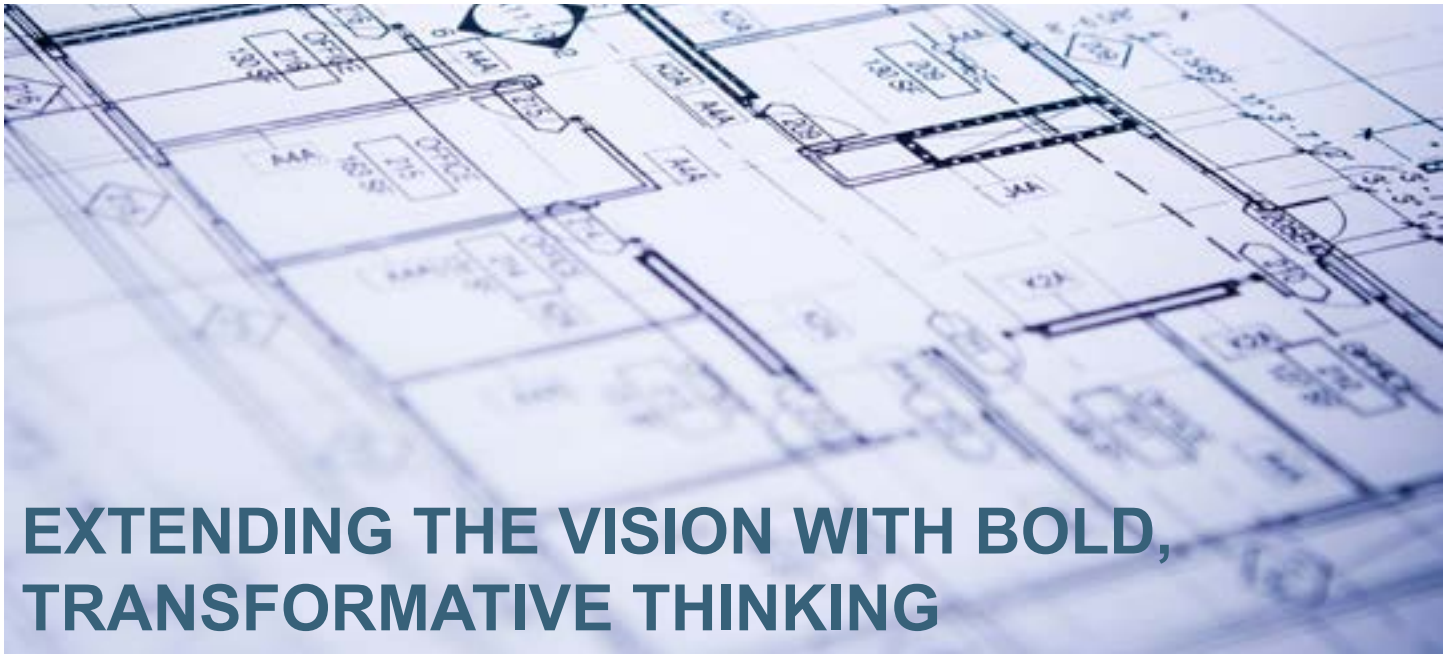
Today's sophisticated resource recovery facilities require highly trained operators that are able to work anywhere in the Nation without obstacles. Unfortunately, the Clean Water Act does not require training or certification of operators. Complicating matters further, most states have unique training requirements, so operators certified in one state will not necessarily be certified in others. The UOTF will require more consistency, with a national base-line standard for operator training and certification, perhaps based on the toughest state standard, which would also allow for reciprocity.

Environmental Education.

UOTFs will need to advocate for themselves through strong programs of environmental education. Today's students are tomorrow's legislators, ratepayers, and the children of today's legislators and ratepayers. Thus, it is essential to acquaint children with the importance of water to public health and, ultimately, the welfare of society. UOTFs also need to make the broader public benefits case regularly to legislators, governing boards, ratepayers, and the press, demonstrating delivery of value for money and reminding the public of the environmental and economic services they deliver every day.

Environmental Management Systems to Set Priorities. An Environmental management system (EMS) is a framework that helps any organization achieve its environmental goals through consistent control of its operations. An EMS addresses regulatory demands and other objectives like energy conservation or reduction of infiltration and inflow to collection systems in a systematic and cost-effective manner, setting priorities to reduce risks of non-compliance and improve public health and safety outcomes for the public and employees, respectively.[39] In practice, clean water agencies have found that An EMS also enables the organization to capture institutional knowledge, making it available to future decision makers, and ensuring continuity over generations of leadership and management.

Smart Technology to Improve Service Delivery and Customer Care. Web-enabled tablets, smart phones, and cloud-based communications have transformed the way clean water agencies deliver services and interact with their customers. They enable customers to share information instantaneously about service disruptions, faulty infrastructure, and meter figures as backup to automated readings. Work orders can be routed efficiently to field crews according to their location, enabling fast response times. They also enable work crews in the field to access and update vital information stored centrally about asset location, condition, and performance. Smart phones allow customers to track progress against work requests in real time. Credit card and check payments using mobile devices linked to central billing and collection databases avoid labor-intensive turn-off/turn-on trips. Social media allows dissemination of critical information to customers to support both routine and emergency activities. Smart meters enable automated, labor-free two-way monitoring, communication, and control (customer to utility and vice versa) of usage patterns for billing and for customer awareness. GPS devices on agency vehicles enable greatly improved accounting and accountability of rolling stock and field labor, saving thousands in fuel costs.



EXTENDING THE VISION WITH BOLD, TRANSFORMATIVE THINKING

The previous section examined incentives for, and barriers to, innovation. It proposed ways to change current regulations, financing conventions, risk allocation mechanisms, administrative procedures, and operating efficiencies to broaden incentives and overcome barriers. There is no doubt that these actions will help utilities transition from collectors and handlers of wastewater to resource managers and environmental leaders.

Many believe, however, that we must go beyond changes to current conditions to arrive at the UOTF, that bold and transformative thinking will be needed to effect quantum movement in operating performance, cost, environmental outcomes, and community involvement.

The sorts of initiatives described in this section are ambitious and complex. It will take time to fully define objectives, roles, scopes, milestones, and measures of success. Consequently, only the concepts are introduced in this *Blueprint*.

Congressional Caucus to Advance UOTF Initiatives

Being only a few years into a multidecade transition, and at this early stage, it is difficult to foresee all the possibilities. Under these circumstances, while creating an environment of innovation, it seems prudent to also create forums that enable continuous exchange of ideas as they arise. The utility side of the industry has such forums as do technology developers, design engineers, and solution providers. But no such forum exists at the Congressional level to raise awareness among legislators. And clearly, nothing short of a national strategic initiative will result in the kinds of outcomes needed to meet the challenges of the 21st Century and beyond. A Congressional Caucus on the UOTF is one way to elevate the importance of water to our society and ensure that the federal government is doing everything it can to support the industry.

> ***Action: Congressional leaders from both House and Senate authorizing committees should create a Congressional Caucus to bring together legislators, sector leadership, and leadership from within the regulatory, finance, and related communities. The Caucus would enable systematic evaluation of some of the actions discussed in this Blueprint as well as new approaches to solve problems as they arise. Key federal water agencies would participate, perhaps***

marking the beginning of better federal interagency coordination on water policy and program objectives. Over time, especially in light of inevitable moves to balance the federal budget, one could imagine this group formulating a sensible approach to consolidating the federal role into fewer, more targeted offices and programs.

Creating the Industry of the Future

The future of clean water agencies is emerging largely because of the efforts of dozens of forward thinking leaders in the sector. Regulators, technology developers, consulting engineers, and the industry's professional organizations are supporting this transition. But like any emerging trend, the sector is not yet organized optimally.

The major professional organizations representing clean water agencies can play a key role in organizing the industry to create and sustain the "Industry of the Future." The Task Force that came together under their auspices to create this *Blueprint* can become a powerful driver on their behalf. A concerted movement to organize the clean water sector behind the "Industry of the Future" would include such activities as focused, collaborative research; advocacy for legislative change; advisory services to regulators; public information; and a UOTF knowledge base platform that details and updates the latest UOTF technologies and processes, enabling the Nation's 16,000 clean water agencies to replicate them.

Action: The UOTF Task Force organized to support this Blueprint, working with the clean water industry associations, should be the driving force behind implementation of the actions noted herein, especially those that deal with internal activities and creation of an "Industry of the Future" knowledge base. For those that require regulatory action, the Task Force should work with EPA in the capacity of a UOTF Advisory Board. For those that require Congressional action, the Task Force would represent the industry in hearings.

Replicating Successful Clean Water Agency Programs

The Narragansett Bay Commission (NBC), serving 360,000 residents and 7,700 businesses in Rhode Island's capital, Providence, and surrounding communities, is a leader in the field of energy efficiency and alternative energy for wastewater treatment facilities. The NBC built the first wind farm in the state of Rhode Island when it installed three 1.5 MW wind turbines at its Field's Point facility in Providence. At its Bucklin Point facility in East Providence, the NBC is completing design of a biogas combined heat & power (CHP) project, and a feasibility study to evaluate installing a 2.6-MW solar photovoltaic plant is ongoing. These alternative energy projects, in conjunction with continuous energy efficiency upgrades, have placed the NBC on a path toward meeting its net-zero energy goal.

With the support of an EPA grant, the NBC has established a partnership with Rhode Island's electric utility, National Grid, to conduct Energy Efficiency Technical Assessments (EETAs) of all Rhode Island wastewater treatment facility operations. All 19 wastewater plants in Rhode Island were assessed, and at the completion of the EETA process in 2012, each facility received a technical report identifying energy efficiency measures, including equipment and physical operating control systems which could produce economically feasible reductions in energy use if implemented. The technical reports also included cost-effective cogeneration and use of renewable energy resources that can be implemented by the clean water agencies.

Similar programs could be replicated across the Nation, which would leverage the considerable technical expertise embedded within large clean water agencies to reach thousands of smaller clean water agencies and multiply benefits to the Nation considerably.

An Intergovernmental Partnership to Address Adaptation to Extreme Weather Events

Recent events such as the broad drought in the summer of 2012 or Hurricane Sandy in the fall of 2012 serve as constant reminders both of the critical services that clean water utilities provide and of the vulnerability of their physical structures to extreme weather events. Because centralized facilities are typically sited at the lowest elevation possible to facilitate gravity flow, clean water facilities are particularly susceptible to floods and sea level fluctuations. Complicating matters further, they cannot be moved easily since urban land is generally scarce having been developed over the years since these facilities were first built and because complex networks of sewers were built expecting large treatment facilities at their terminus.

Many argue that building in physical and operating resilience can be a viable and cost-effective solution. Elements of such a solution include physical barriers, redundant components, remote operations facilities, and other sorts of hardening approaches. But these may only buy time, especially if climate change results in more frequent and more severe flooding and/or continued sea level rise. Operational resiliency will help under these circumstances, including for example, broad and well-exercised interlocal cooperation agreements, regional emergency equipment stores available to multiple facilities, citywide command centers to manage through an emergency event, and advance warning systems that enable portions of networks to shut down and perhaps divert flow before systems are hydraulically overloaded. Green infrastructure is the third key element, where hard urban surfaces are replaced by vegetated or permeable surfaces to retain runoff and natural shoreline features such as wetlands, and sand dunes are restored to mitigate the effects of storm surges.

None of these options are inexpensive. Beyond funding, all of these options involve extensive planning, public education and involvement, changes to individual and corporate behaviors, and potential changes in land use.[40]

> ***Action: The Nation's clean water professional associations should organize a coordinated program to synthesize ongoing research and more fully define and recommend elements of a program of action on resilience in response to extreme weather events for the Nation's clean water infrastructure. Based on these recommendations, U.S. Congress should support a concerted 10-year partnership with the states to formulate and help finance infrastructure and other measures to ensure implementation of resiliency plans at all susceptible facilities.***

Creating Real Markets for Water

As more clean water agencies reclaim water to reuse in industrial cooling, landscape irrigation, groundwater recharge, and possibly potable water supplies, questions will arise as to the rights to these sources of supply, especially in the western states that operate under prior appropriations water rights doctrine. A well-defined market for buying and selling water rights within targeted watersheds would support an orderly transition to such reuse and support clean water agencies that wish to create new revenues from the sale of reused water. Aside from the benefits to clean water agencies, well-defined and organized markets for water would help water-short urban centers sustain temporary supplies from less productive users like farmers irrigating marginal lands during droughts.

Water transfers are possible today, and, in fact, there are more than two decades of experience in states like California with modest numbers and types of transfers, although they have declined in number in recent years.[41] The market could be significantly strengthened if either or both state agencies that administer water rights systems within their states and/or the federal government in their capacity to create and define rules within federal interstate water management compacts better define and possibly manage a market for public and private buyers and sellers of water rights.

Facing severe drought for more than a decade, such interventions by the Australian government did exactly this.[42] The Australian water market is considered by many to be the most sophisticated in the world, with more than $3 billion in trades per year. Water rights can be bought and sold separately from land rights and traded on an open market, generally within watershed boundaries. Investors can buy entitlements to water and rent them back to irrigators, or sell the rights into the temporary transfer market. The Australian Government is pursuing a number of initiatives to improve the functioning of water markets: working with basin states to remove barriers to water trade, developing a National Water Market System that will assist in the efficient management of water registry, transaction and market information functions; and creating and updating market rules. Private water market intermediaries (e.g., water brokers and exchanges) play an important role in the market by bringing buyers and sellers together, reducing search costs, improving information flows, and assisting in obtaining regulatory approvals

Action: The professional organizations representing the clean water industry should initiate an examination, perhaps with such organizations as the Western Governors Association or the Council of State Governments, to examine in detail whether and the extent to which the states acting individually or with input from federal water agencies like the U.S. Bureau of Reclamation could better support water markets to define rights for recycled water and achieve more efficient allocation of all source waters (including recycled water), especially during extreme weather events.

CONCLUDING THOUGHTS

Clean water agencies face unprecedented challenges in the coming decade. Fiscal pressures have never been greater. Infrastructure upgrades, expansions, and replacement have never been more critical. Regulatory demands to control nutrients, combined sewer overflows, and sanitary sewer overflows have never been stronger.[43] Future threats of system failure from extreme weather events have never seemed more real.

Yet there is cause for optimism. Sector leadership is stronger than ever. Technology innovation is emerging as a driving force offering design engineers options to make great strides in process efficiency while reducing costs. And most importantly, the sector as a whole is beginning to understand its central role in economic and social well-being. In short, the Utility of the Future is becoming real.

Just a few years into a generational paradigm shift, we cannot fully envision its limits. We do know that each clean water agency will take a somewhat different path from handlers of wastewater to managers of sustainable resources; from regulated entities seeking permit compliance to watershed-scale environmental leaders seeking least-cost environmental and social solutions; from engineers designing concrete and steel treatment works to regional planners designing and building weather-resilient, green communities; from isolated public service units to integrated members of economically thriving local economies.

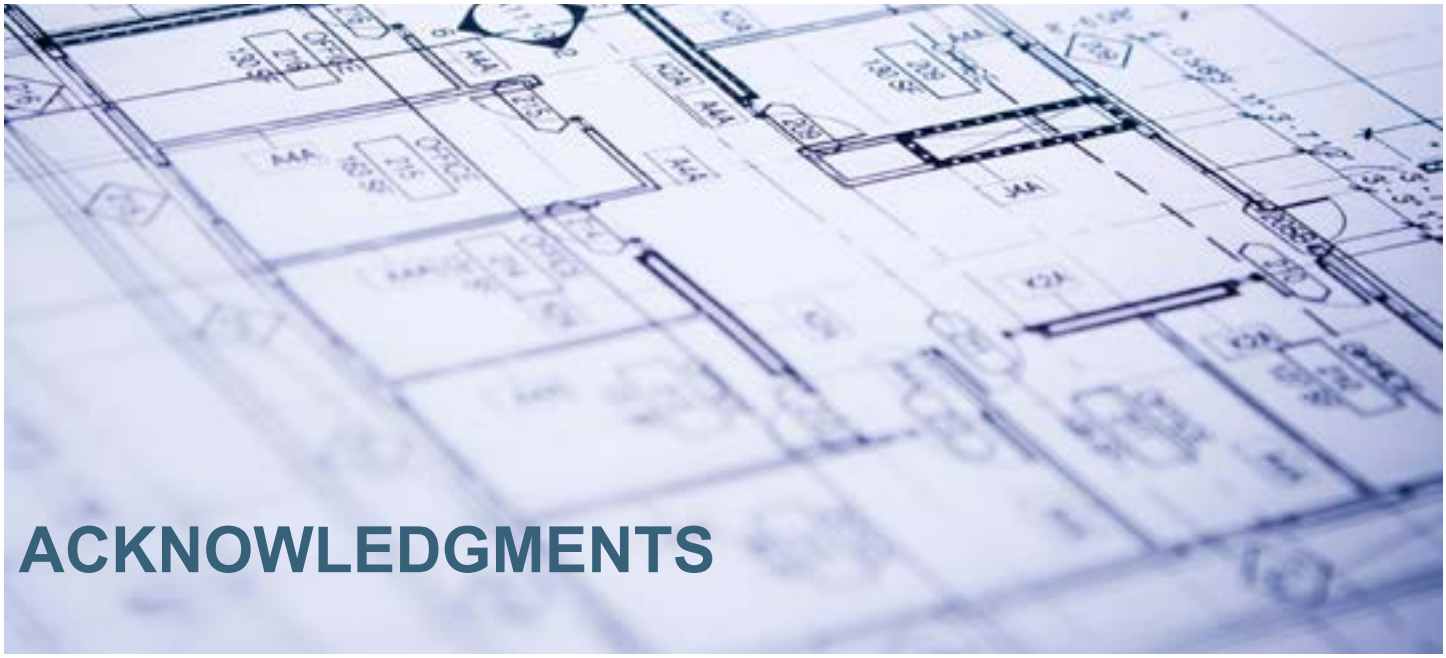
The actions described in this *Blueprint* are important steps. But despite initial optimism, these steps alone may not be enough. We should build on our momentum to go beyond the Clean Water Act by engaging legislators, industry practitioners, and technology innovators in a conversation about a 21st Century Watershed Act. The Congressional Caucus introduced earlier would be an ideal forum for such a conversation.

A 21st Century Watershed Act would find its roots in the foundations of the 1972 Clean Water Act that called on regulators and the regulated community to find solutions to America's water quality challenges by working together at the area-wide or watershed scale. The 1972 Clean Water Act embodied several parallel approaches to meet clean water goals: watershed planning, financial incentives to help clean water agencies upgrade and expand treatment works, a system of legally enforceable water quality requirements and discharge permits with penalties for point sources that failed to meet them, and funding for science and technology to fill knowledge gaps needed to justify requirements and permit conditions.

We have accomplished a great deal with these programs, and the Nation benefits from significantly cleaner water bodies. Over time, however, Clean Water Act priorities have focused much more narrowly on enforcing tighter and tighter discharge limits to the point that future water quality returns to this 40-year old approach will be sharply lower than we have enjoyed in the past, and whatever gains may be possible will come at greatly increased costs. Already reduced federal clean water funding is threatened further by budget concerns, tax-exempt public capital markets appear shaky in the current tax-reform debate, and, increasingly, communities are reaching their limits of affordability of clean water services. The emergence of UOTF initiatives is clear evidence that a new direction is emerging, that the paradigm has changed.

A new 21st Century Watershed Act would acknowledge this paradigm shift and help realign regulatory expectations, federal programs, and the emerging leadership role of America's clean water agencies as they explore and implement UOTF initiatives described herein. Such an Act would recreate the partnerships previously enjoyed between EPA, state regulators, and clean water agencies. It would embrace sound science based on ecosystem-wide management decisions and holistic evaluation of watersheds to determine sustainable solutions. It would encourage the examination of the historical record for the receiving water to ensure that all causes of impairment are understood and controlled. It would allow for the sorts of watershed processes like adaptive management discussed earlier and "smart engineering" methods to be incorporated as elements of the TMDL process. It would encourage green infrastructure and other solutions that go beyond chemistry in the water column to restore and create fisheries and wetlands or make shorelines more resilient to extreme weather events while creating the jobs of the future.

The vision of fishable, swimmable waters is something we all share, but new directions are needed if we are to achieve our goals. The progress we are making today is strong evidence that new approaches to resources management are possible, that America's clean water agencies are prepared to lead, and that communities across the Nation are motivated to work together to find least-cost water and resource management solutions that improve local economies and the quality of life. A 21st Century Watershed Act would set this new direction legislatively and launch the next increment of success in water resources management.



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Steering Committee

The Steering Committee was made up of nine members–three from each of the partnering organizations–and was tasked with providing high-level oversight to ensure that the *Blueprint* achieved the goals set out in the proposal framing the project.

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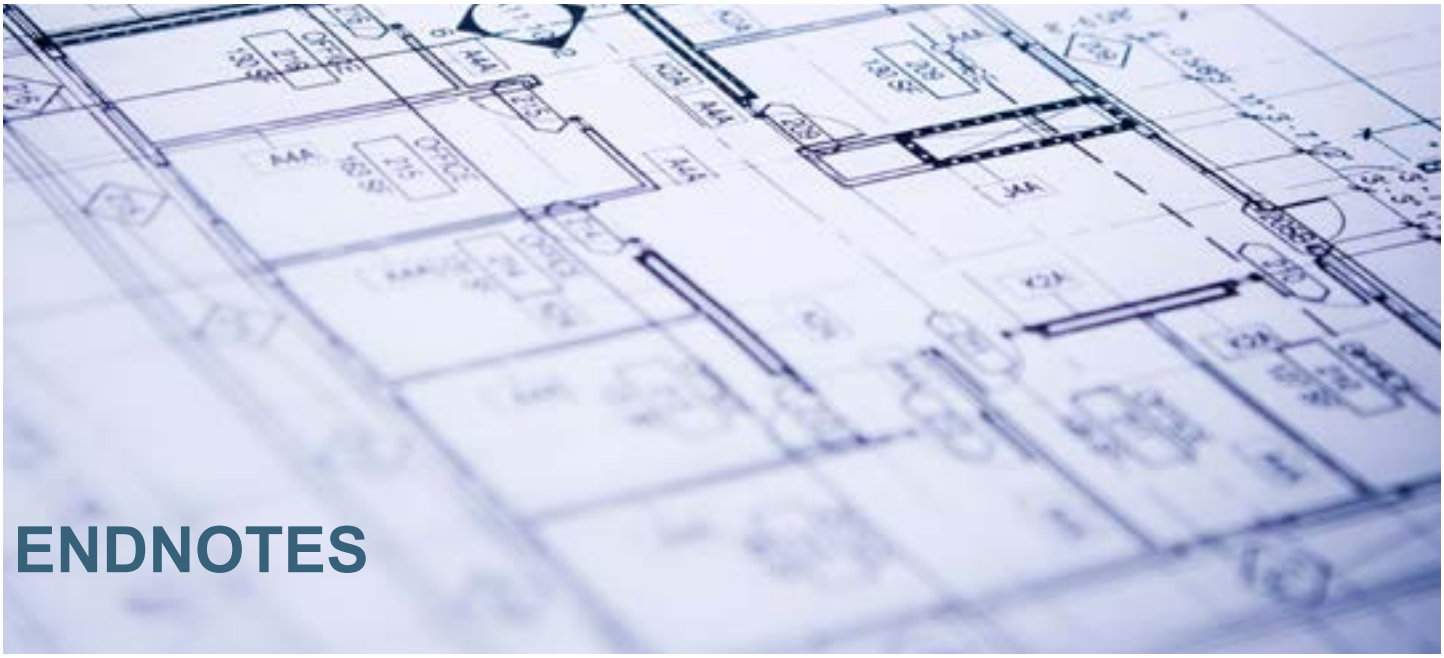


ENDNOTES

1 BMJ 2007; 334:111.2 http://dx.doi.org/10.1136/bmj.39097.611806.DB (January 18, 2007).

2 U.S. Environmental Protection Agency, *Clean Watersheds Survey Report to Congress* (2008); U.S. Bureau of the Census, *State and Local Government Finances* (2010); U.S. Bureau of Labor Statistics, *State and Metro Area Employment* (2012).

3 National Association of Clean Water Agencies, *Two Sides of the Same Coin: Increased Investment & Regulatory Prioritization* (2011) and Controlling *Nutrient Loadings to U.S. Waterways: An Urban Perspective* (2012).

4 Agriculture is by far the greatest source of pollutants that impair U.S. waters. Other sources of impairment of rivers and lakes that exceed municipal sources include atmospheric deposition, hydro-modification, and runoff from urban and rural lands. For details, see: USEPA ATTAINS database and Section 305(b) reports to the U.S. Congress, various years.

5 By comparison, Israel reuses 70 percent, Singapore reuses 30 percent, and Australia reuses 8 percent, with a national goal of 30 percent by 2015. For details, see: http://www.nvwra.org/storage/2011/conference/presentations/presMillerWade.pdf.

6 Survey of members of the National Association of Clean Water Agencies, September 2012.

7 Ibid.

8 For details, see National Association of Clean Water Agencies, *Controlling Nutrients to U.S. Waterways: An Urban Perspective*, October 2011.

9 Where there is “reasonable assurance” that non-point sources will reduce their nutrient pollutant loadings, a state may allocate more of the needed loadings reductions to non-point sources instead of more stringent point source reductions. In their recent review, however, the states and EPA concluded that allocation in the absence of enforcement is unreliable: “*States have undertaken and explored different limited approaches to control non-point sources. Authority at the federal level for state development of effective, enforceable and transpar-*

ent non-point source accountability is lacking." For details, see: *State-EPA Nutrient Innovations Task Group, An Urgent Call to Action*, a report to the Administrator of the U.S. Environmental Protection Agency, August 27, 2009, page 19.

10 Op cit. National Association of Clean Water Agencies. Also, see: Ohio EPA Rules for Water Quality Trading, Ohio Administrative Code Ch. 3745-5.

11 See Water Environment Research Foundation, *Energy Opportunities in Wastewater and Biosolids*, unpublished White Paper, April 2009.

12 For details, see: http://www.epa.gov/ttn/atw/129/ssi/ssipg.html.

13 For details, see: http://www.law.cornell.edu/uscode/text/26/141.

14 For details, see: http://www.c2es.org/us-states-regions/policy-maps/renewable-energy-standards

15 National Research Council, Water Science and Technology Board, National Academy of Science, *Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater*, The National Academies Press, Washington D.C., 2012.

16 Though each state has its own set of rules and conventions, generally the western states allocate water to users following a prior appropriations doctrine whereas the Eastern states follow the riparian use doctrine. There are many fine books that present the details of state water laws, including for example, A Dan Tarlock, *Law of Water Rights and Resources*, Clark Boardman Environmental Law Series, New York, 1988-2010.

17 Op. cit., National Research Council, pages 123-130.

18 The City of San Diego CA, which imports 90 percent of its water, has attempted and failed to implement potable wastewater reuse since 2004. See: http://www.sandiego.gov/water/waterreuse/index.shtml.

19 These include: the Environmental Protection Agency, Department of the Interior (Bureau of Reclamation), Department of Commerce, Department of Agriculture, Department of Energy, General Services Administration, U.S. Geologic Survey, U.S. Army Corps of Engineers, and Department of Defense.

20 See: U.S. Environmental Protection Agency, *Clean Watersheds Needs Survey 2008 Report to Congress*, EPA-832-R-10-002, Office of Wastewater Management, Washington, D.C.

21 Integrated water resources planning and management has been the focus of literally thousands of journal articles and hundreds of professional and scientific conferences over the years. As water grows scarcer and costlier, incremental progress toward this goal is inevitable. For a contemporary look at integrated water management as it relates to the UOTF, see: U.S. Water Alliance, *Managing One Water*, 2010.

22 See, for example: Joe Zuback, *Strategies for Accelerating Adoption of New Cost-Saving Water Technologies and Solutions in a Risk-Adverse Market*, presented at the 104th annual meeting of the Water and Wastewater Equipment Manufacturers Association, Las Vegas, Nev., November 2, 2012.

23 Although both the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency have limited authorities to provide assistance to local entities for recycling projects (e.g., specific provisions for the Corps in 1992 and 1999 Water Resources Development Acts; a pilot program by EPA under the Alternative Water Sources Act; and general Clean Water Act water treatment and wastewater authorities), neither has an established, regularly funded program dedicated to such activities. For details, see: Betsy A. Cody and Nicole T. Carter, *The Title XVI Water Reuse Program: Implementation and Legislative Issues*, U.S. Congressional Research Service, October 27, 2006.

24 For complete guidance on these and other DOE programs, see: http://www1.eere.energy.gov/wip/guidance.html.

25 Most state loan funds are targeted at specific borrowers in the private sector or low-income households, so loan availability may be limited. For details, see: http://www1.eere.energy.gov/wip/pdfs/sep_rlf.pdf.

26 The National Association of Clean Water Agencies has been on the forefront of advocating for SRF funding either in its current form or in the form of a Federal Clean Water Trust Fund. The Water Environment Federation also has been a strong supporter of SRF funding and more recently has called for a new Water Infrastructure Finance and Innovation Authority (WIFIA) to be created.

27 For details, see: http://water.epa.gov/infrastructure/greeninfrastructure/gi_support.cfm.

28 Programs include the Conservation Reserve Program, Conservation Stewardship Program, Environmental Quality Incentives Program, and Wetlands Preserve Program. For details, see: National Association of Clean Water Agencies, *Controlling Nutrient Loadings to U.S. Waterways: An Urban Perspective*, October 2011.

29 See: http://arpa-e.energy.gov/About/About.aspx.

30 For details, see: http://www.werf.org/lift/Home/lift/Home.aspx?hkey=2cd855fd-d6da-44b2-a6ae-92c66436a704.

31 This leader of this consortium is Southern Nevada Water Authority. Isle Utilities organizes the iTAG. See: http://www.isleutilities.com/.

32 Op cit., National Research Council, page 1.

33 General Electric Company, GE Water Reuse Survey, *Executive Summary of U.S. Findings*, October 23, 2012.

34 Op Cit., National Research Council, page155.

35 For details, see: http://www.watereum.org/.

36 U.S. Environmental Protection Agency, Association of Metropolitan Water Agencies, American Public Works Association, American Water Works Association, National Association of Clean Water Agencies, National Association of Water Companies, and Water Environment Federation, *Effective Utility Management: A Primer for Water and Wastewater Utilities*, (June 2008) for details, see www.watereum.org/resources/.

37 These methods are similar to the initiatives that NACWA pioneered in the 1990s in their guidance and sector workshops, *Thinking, Getting, and Staying Competitive: A Public Sector Handbook, and High-Performance Business Services*.

38 For a thorough examination of Lean and Six Sigma in the water and clean water sector, see: *Environmental Protection Agency, Resource Guide to Effective Utility Management and Lean: Improving Performance and Addressing Key Management Priorities at Water-Sector Utilities*, U.S. Environmental Protection Agency, November 2012 Review Draft.

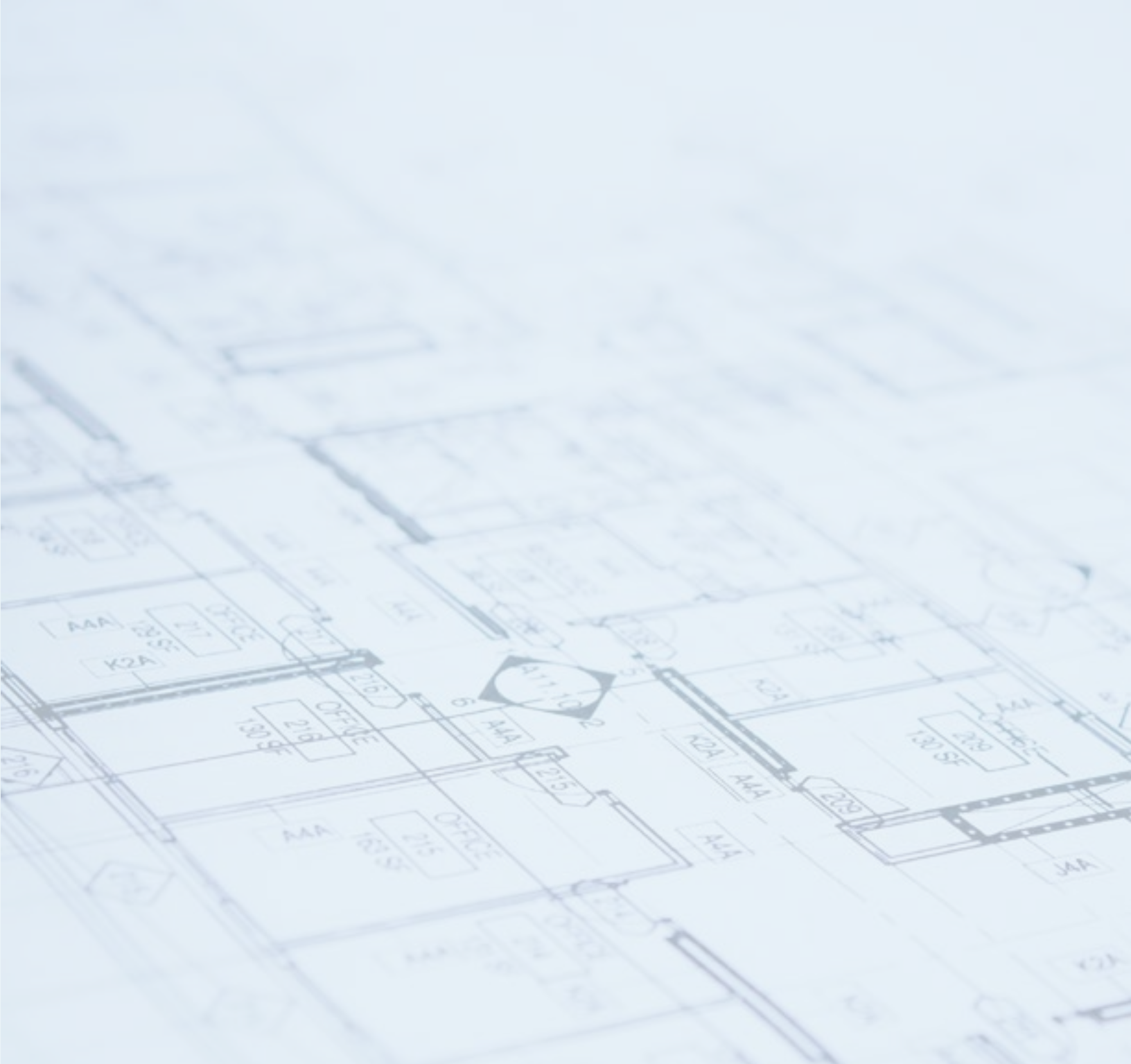
39 For details, see: http://www.wef.org/AWK/page.aspx?id=2477.

40 Many initiatives are already under way to address resiliency of U.S. water and wastewater infrastructure, including for example, the Water Utility Climate Alliance (members include Central Arizona Project, Denver Water, the Metropolitan Water District of Southern California, New York City Department of Environmental Protection, Portland Water Bureau, San Diego County Water Authority, San Francisco Public Utilities Commission, Seattle Public Utilities, Southern Nevada Water Authority, and Tampa Bay Water). EPA has several programs addressing resiliency of infrastructure such as their CREAT software that enables utilities to evaluate the vulnerability of their assets to extreme weather events and broadly, plan resilient activities to reduce risks or EPA's Community-Based Water Resiliency Initiative to assess resilience of infrastructure to service interruptions. See: http://www.wucaonline.org/html/, http://water.epa.gov/infrastructure/watersecurity/climate/creat.cfm, or http://water.epa.gov/infrastructure/watersecurity/communities/.

41 According to one recent analysis, there have been a little less than 200 recorded water rights transfers (short- and long-term sales and leases) per year over the period 1987–2007. See *Zachary Donohew, Property Rights and Western United States Water Markets*, The Australian Journal of Agricultural and Resource Economics, 53, pages 85-103, 2009.

42 Water use laws and conventions in Australia, originally very similar to the United States, underwent broad reform largely in response to sustained drought, which suggest a strong potential for learning and transfer. Australia's federal Commonwealth Government is responsible for policy leadership, planning, and funding while states are responsible for laws that govern water use and allocation of water rights within their states. Australia's Water Management Act of 2000 created separate rights for extraction/diversion of surface or groundwater and for the right to use water at a specific place for a specific purpose. Using an extensive public involvement process, the Act also prioritized water uses in times of shortage, from highest to lowest: Domestic, environmental, commercial and urban uses, and irrigation. The Water Act in 2007 implemented Australia's National Water Initiative, which among other things, created the Murray-Darling Basin Authority to coordinate basin planning and water management in this watershed serving about a quarter of the country's population and most of its agricultural production across three of Australia's five mainland states. For details, see the website of Australia's National Water Commission at: http://nwc.gov.au/.

43 For details on these issues and a general presentation of financial changes and challenges in the clean water sector, see National Association of Clean Water Agencies, *Two Sides of the Same Coin…Money Matters – Increased Investment and Regulatory Prioritization* (2011) and *The Message is Clear…Money Matters – Smarter Investment to Advance Clean Water* (2011).



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