INNOVATING FOR A SUSTAINABLE AND RESILIENT WATER FUTURE

A REPORT FROM THE 2014 ASPEN-NICHOLAS WATER FORUM

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

THE ASPEN INSTITUTE
ENERGY & ENVIRONMENT
PROGRAM

For all inquiries, please contact:

Energy & Environment Program
The Aspen Institute
One Dupont Circle, NW
Suite 700
Washington, DC 20036
Phone: 202.736.2933
Fax: 202.467.0790

Nicholas Institute for Environmental Policy Solutions
P.O. Box 90335
Duke University
Durham, NC 27708
Phone: 919.613.8709
Fax: 919.613.8712
nicolasinstitute@duke.edu

The Aspen Institute
One Dupont Circle, NW
Suite 700
Washington, DC 20036

Published in the United States of America in 2014 by The Aspen Institute

Printed in the United States of America
Publication Number: 14/014

INNOVATING FOR A SUSTAINABLE AND RESILIENT WATER FUTURE 2014.
Martin Doyle, Water Policy Program Director, Nicholas Institute for Environmental Policy Solutions, Duke University; David Monsma, Executive Director, Energy & Environment Program, the Aspen Institute; Courtney Harrison, Policy Associate, Nicholas Institute for Environmental Policy Solutions, Duke University; and Nicole Buckley, Senior Program Manager, Energy & Environment Program.

Cover photo courtesy of Neil Kremer @flickr

INNOVATING FOR A SUSTAINABLE AND RESILIENT WATER FUTURE

A REPORT FROM THE 2014 ASPEN-NICHOLAS WATER FORUM

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

THE ASPEN INSTITUTE
ENERGY & ENVIRONMENT
PROGRAM

The Aspen Institute is an educational and policy studies organization based in Washington, D.C. Its mission is to foster leadership based on enduring values and to provide a nonpartisan venue for dealing with critical issues. The Institute has campuses in Aspen, Colorado, and on the Wye River on Maryland's Eastern Shore. It also maintains offices in New York City and has an international network of partners. *www.aspeninstitute.org*

The Aspen Institute **Energy and Environment Program** provides nonpartisan leadership and a neutral forum for improving energy and environmental policymaking through values-based dialogue. With its intentional dialogues, public programs, annual policy forums, and an environmental leadership initiative, the program creates impartial venues for global leaders to engage in informed discussion around energy and environmental challenges and solutions. The Program's core competency is convening professional, high-level, content-driven dialogues in the policy, science, finance, and business arenas. The Program convenes strategic groups of experts from government, business, academia, and nonprofit organizations in dialogue structured and moderated for discussion, exploration, and consensus building.

The Nicholas Institute for Environmental Policy Solutions at Duke University improves environmental policymaking worldwide through objective, fact-based research to confront the climate crisis, clarify the economics of limiting carbon pollution, harness emerging environmental markets, put the value of nature's benefits on the balance sheet, develop adaptive water management approaches, and identify other strategies to attain community resilience. The Nicholas Institute is part of Duke University and its wider community of world-class scholars. This unique resource allows the Nicholas Institute's team of economists, scientists, lawyers, and policy experts not only to deliver timely, credible analyses to a wide variety of decision makers, but also to convene these decision makers to reach a shared understanding regarding this century's most pressing environmental problems. *www.nicholasinstitute.duke.edu*

The Aspen-Nicholas Water Forum is the third forum on which the Aspen Institute and the Nicholas Institute have partnered. The first, in 2005 on water, sanitation, and hygiene in the developing world, produced *A Silent Tsunami*, which made a material contribution in advancing priority in U.S. foreign assistance for basic water services. The report ultimately helped spur passage of the Paul Simon Water for the Poor Act. In 2011, the two institutions again joined together to host a one-day forum to take stock of progress, documented in *A Silent Tsunami Revisited*. The success of these endeavors provided the impetus for additional forums, specifically a forum focused on water concerns in the United States.

TABLE OF CONTENTS

PREFACE

With shocking water crises in the news this year, the urgent need for infrastructure upgrades and resilience building in our water systems has been made clear. What was once anomalous is emerging as the norm: drought in the West, intense rainstorms in the East, contamination in Charleston by coal-processing and in Toledo by toxic algal blooms, debt in Detroit, where the water department turned off water to thousands of users with delinquent bills, and degrading infrastructure that causes leaky and bursting pipes across the country.

These are not emerging issues of climate change, population growth, new contaminants or financial constraints. They are outcomes of the convergence of these challenges combined with the realities of undervalued water, policies that preserve the status quo, and under-financed and degraded water systems.

To address these pressing water issues and the need for leadership and action, the **Aspen-Nicholas Water Forum** in May 2014 brought together water experts with diverse knowledge—from finance and policy to technology and ecosystems. Motivated to find the path forward to a sustainable water future, these experts welcomed the opportunity for cross-sector dialogue.

This report was written in collaboration with the Nicholas Institute for Environmental Policy Solutions at Duke University and the Aspen Institute. Though the authors have attempted to capture the ideas and sentiments expressed during the forum, not all views were unanimous nor were unanimity and consensus sought. Forum participants and sponsors are not responsible for its content.

The Aspen Institute and Nicholas Institute for Environmental Policy Solutions thank the following sponsors for their generous support: Goldman Sachs, Water Asset Management, GE, the National Renewable Energy Laboratory, Duke Energy, Intel, the Cynthia and George Mitchell Foundation, and American Water. We also thank our forum rapporteurs, Courtney Harrison and Nic Buckley, who distilled the richness of the wide-ranging discussions into this summary. Finally, we thank Gordon Binder at the World Wildlife Fund for his ongoing guidance and inspired way with words.

The Aspen Institute and Nicholas Institute intend to continue to collaborate to develop forward-thinking pathways to address the state of the U.S. water system. This forum probed many topics currently ripe within the water sector. Future water forums will move beyond general scoping toward executable proposals. Our hope is that the U.S. water industry can become a model sector for innovation and climate resilience.

David Monsma
Executive Director
Energy & Environment Program
The Aspen Institute

Tim Profeta
Director
Nicholas Institute for Environmental
Policy Solutions
Duke University

INTRODUCTION

Among great infrastructure achievements—including the Transcontinental Railroad, the Interstate Highway System, electrification, and the information economy—America's water infrastructure is frequently overlooked. Almost without exception, one can fill a glass with tap water in Tampa or Tacoma or Tucson, and drink the water without concern. Yet this feat, which combined engineering, planning, policy, and finance, and which required a significant investment of resources, is largely taken for granted. As we look ahead, too many presume that the water sector's ability to provide continuing upkeep and respond effectively to new challenges is guaranteed.

In May 2014, the Nicholas Institute for Environmental Policy Solutions at Duke University and the Aspen Institute Energy and Environment Program hosted the **Aspen-Nicholas Water Forum**, a roundtable discussion to address ongoing challenges to our water systems. The participants—50 thought leaders from the private sector, government, academia, and nongovernmental organizations—represented expertise in finance and investment, utility management, federal and state policy, ecosystem management, environmental protection, technology, land use planning, energy, corporate water management, agriculture, and communications.

Though some steps have been taken to bolster our national water infrastructure to deal with severe weather, growing populations in arid places, threats to ecological health, and climate change, they are as yet inadequate to create transformative change. During the forum, participants explored the future of our water system; the role of corporations and municipalities in managing water risk; and the innovations in, and convergence of, water policy, finance, and technology to identify potential game changers.

What became clear is that innovations are occurring at the local level as inventive water utilities are taking bold long-term steps to address systemic issues in water systems, as well as region- or city-specific issues. State and federal governments need to support these efforts to help ensure new ideas meet regulatory objectives and to identify opportunities to scale these innovations, translate them, or both, and to disseminate information about effective practices. Participants also identified fragmentation among surface water, stormwater, wastewater, and other systems as inefficient and called for policies—though not necessarily federal policies—to enable the collective management of various water resources.

Optimism punctuated sessions on both water finance and technology innovations: needed knowledge exists, and needed technologies exist or are on the verge of development. For progress to continue, however, the siloes of expertise within the water industry and government agencies must be addressed.

There are significant sources of institutional capital focused on opportunities for infrastructure development and market liquidity. The long dated stable nature of these assets are also appealing to some institutional and pension investors. Additionally, public-private partnerships have potential if stakeholders learn to appreciate and incorporate the particular strengths that different sectors bring to the discussion.

Technologies are rapidly developing around demand-side management and quality; however, integrating them into ongoing operations remains a challenge. In addition, data aggregation and analysis, particularly real-time analysis, and use of data for optimal water management are lacking.

All of these challenges represent nascent opportunities for increasing water sustainability—but they cannot be addressed by a single sector of the water industry, a single layer of government, or a single type of investor. Synergetic approaches are needed to develop truly novel solutions.

Over two days of informed, often provocative dialogue, there emerged the need for the following near-term action:

- disseminating **innovations developed by leading utilities** to smaller utilities;
- strengthening water sector leadership and innovation for **climate change resilience**;
- generating awareness around the **value of water**;
- facilitating **data integration** to improve water management; and
- addressing the **federal-state-local tensions** in water resource management.

The following report summarizes the discussions that led to these observations and extrapolates on these key priorities for the U.S. water sector.

THE STATE OF U.S. WATER INFRASTRUCTURE

THE WATER SECTOR TODAY

The U.S. population is projected to reach 438 million by 2050; the larger part of that anticipated growth is in the coastal West, Southwest, and Southeastern regions. At the same time, climate change is predicted to increase the frequency and magnitude of droughts and intense precipitation events leading to floods. What was previously considered a 100-year event has often become a 30-year or even 10-year event. California, which produces more than a third of the country's vegetables and nearly two-thirds of the country's fruits and nuts, is in a state of drought emergency. Water levels in Lake Mead have dropped to an all-time low, and the Bureau of Reclamation has called for an adjustment in water delivery along the Colorado River in the fall to address Lake Mead's decreased water levels. In Washington, D.C., emergency warnings about the potential for coastal flooding are now broadcast weekly.

In the United States, 44% of stream miles and 64% of lakes are not clean enough for swimming or for human consumption of fish.

Many ecosystems across the United States remain vulnerable and are declining, if not collapsing. The U.S. Environmental Protection Agency estimates that in the United States, 44% of stream miles and 64% of lakes are not clean enough for swimming or for human consumption of fish. The Clean Water Act of 1972 was an unprecedented success in addressing industrial and municipal pollution, and river and stream conditions have improved. Yet the Achilles' heel of the Clean Water Act, and of state regulations, remains nonpoint source pollution delivered from agricultural fields, parking lots, suburban lawns, and so on.

Without the ability to regulate nonpoint source pollution, water utilities are left as the last line of defense between pollution and aquatic ecosystems, and they thus bear an increasing brunt of the costs. For example, DC Water's current nutrient reduction project, which is now necessary for regulatory compliance, is projected to cost $1.1 billion. If the federal government or state governments increase regulatory require-

ments around nonpoint source pollution, this will decrease the burden on water utilities that is both unsustainable and increasing.

In periods of water scarcity, the environment is frequently the first to come up short. California, for example, relaxed aspects of programs implementing the Endangered Species Act in order to provide water from the Sacramento-San Joaquin Delta to southern California users. During the 2007–2008 drought, flows in rivers of the southeastern United States required to sustain threatened aquatic species were similarly reduced to meet municipal and industrial water supply demands. When in conflict with cities, species and their ecosystems have inevitably been on the losing end.

Due to prolonged pumping in amount that exceed recharge rates, groundwater levels have dropped significantly. From 2000 to 2008, the rate of depletion was nearly three times higher than the twentieth century average. In the Midwest, the Ogallala aquifer, the primary source for irrigation and drinking water in this major agricultural region, has experienced large water-table declines (exceeding 164 feet in some places). Still, states are reticent to regulate groundwater pumping, and knowledge about how much water remains in this and other aquifers is lacking.

Past predictions of water-related disaster in the United States were avoided—and water quality improved over time—because laws and governance structures were adopted.

Meanwhile, our investment in infrastructure over the past century is, at best, creeping along. The American Society of Civil Engineers gave water infrastructure across the country a D+ grade and noted an annual funding shortfall of $11 billion alone to replace pipes that have exceeded their useful life. Broken pipes disrupt service, and leaking pipes lose approximately 18% of water that has already been stored, transferred, pumped, and treated.

The public perception that water is plentiful and should be freely available makes it nearly impossible to raise water rates to a level that would pay the full cost of water services. When Detroit Water Works threatened to turn off water to 30,000 water users (approximately 40% of its customers) with outstanding water bills, the United Nations Special Commission for Water and Sanitation issued a statement demanding that the water be turned on for all of those who cannot afford to pay their bill because "water is a human right."

Many appreciate that access to water and sanitation should be universal, but the quality of these services will continue to diminish if a way to pay for them is not secured. As one forum participant noted, "utilities are not so much providing water as providing water service: delivery of plentiful, clean water at inordinately low cost." This includes the treatment of water both before and after use. At the same time, as

water rates rise, and they have been in many places across the country, water utilities recognize that less affluent households may need special help to pay their water bill.

Business as usual in the U.S. water sector and by water users is predicted to substantially increase the risk from the impact of deteriorating infrastructure, extreme weather events, and excessive water consumption. Diverging from this unsustainable trajectory will require institutional shifts within the water sector, the inclusion of water risk in the business growth strategies of large water users, and the integration of efforts among all stakeholders within watersheds.

This is not the first time that the calls of crisis have been heard. In 1956, the novelist Philip Wylie wrote that America's growing crisis was water, noting that New York City had almost run out of its water several times during that decade and that the citizens of Dallas were buying water in milk cartons at 50 cents a gallon. He worried about whether children of the 21st century would be living in an American Sahara. Wylie was not alone. In the 1969 issue of Time Magazine bearing the infamous photograph of the burning Cuyahoga River, a special section was devoted to urban water problems: aging infrastructure, water pollution, funding challenges, and lack of watershed-level coordination. One would be hard pressed to distinguish a water article from the 1950s and 1960s from more recent articles.

Past predictions of water-related disaster in the United States were avoided—and water quality improved over time—because laws and governance structures were adopted. Crisis drove action. But action to fend off crisis often is inefficient and stymies investments to create systems for a sustainable water future. The structures developed under duress of crisis are what continue to guide current systems and processes.

To transcend current conditions and challenges, water industry leaders need to develop a clear message of urgency and establish a national presence promoting an industry vision and roadmap for the coming decades. This message and vision must be integrated with urban planning and management, energy, and agriculture policies. Challenges include the limited and siloed nature of funding from federal and state governments for water system improvements, deteriorating infrastructure overwhelmed by maintaining the status quo and withstanding disasters, limited political will for rate increases, and an aging water sector workforce.

UNDERSTANDING WATER RISK

Because water is viewed as a low-cost, high-quality, infinitely available resource, it is not typically regarded as a priority for political decision makers, businesses, agricultural producers, or even households. Consequently, water management is frequently crisis driven, increasing overall risks to water systems.

These risks can be categorized as *physical* (relating to availability and to quantity or quality needed for a particular use); *reputational* (relating to public perception and the effect of one use on other uses); and *regulatory* (relating to legal acquisition, use and discharge). They are each perceived differently by corporations, water utilities, and investors, as described in this section.

Corporate perspective

Although a growing number of companies are assessing water risk as part of their long-term business strategies, they frequently consider that risk to be a compliance issue. Most companies still tend not to prioritize water issues as though they were relevant to their core business or a part of their growth strategy. Until water risk is viewed as a material business risk, it will remain an interesting data point, but it will not drive decision-making nor become a priority for investment. The risk needs to be quantified as a financial risk to gain the attention of companies' financial officers. Demonstrating reputational risk due to poor water management has been one successful method for gaining that attention.

Until water risk is viewed as a material business risk, it will remain an interesting data point, but it will not drive decision-making nor become a priority for investment.

More companies are beginning to voluntarily disclose information about their water use and perceived water risk to NGOs such as the Carbon Disclosure Project and the Global Reporting Initiative. On the basis of these data, a recent report from the Pacific Institute and VOX Global found that companies believe their water risk is well managed. Companies' approaches to water can be visualized on a maturity spectrum ranging from no strategy, to managing water risk within the fence line (water reuse and recycling), to making ad hoc assessments of individual facilities, to integrating water risk fully into enterprise risk. At this highest level of maturity, companies are engaged with neighboring stakeholders to manage water sustainably in the watersheds within which they operate.

Even though an increasing number of companies are disclosing water use information and report satisfaction toward their management of risk, few companies have reached full maturity when it comes to water management. Reporting data are still not readily accessible, particularly for assessing the value chain for consumer product companies. Consequently, the financial cost of water *appears* to be low, reducing the potential for water efficiency innovation.

Investor perspective

Through platforms such as the Carbon Disclosure Project as well as the Sustainable Accounting Standards Boards (SASB), there has been a greater push to increase dis-

closure of various sustainability metrics including water risk disclosures because they anticipate that inadequate water resource management may lead to material impacts to a company's financial position. They are seeking robust analyses of potential management outcomes to establish the timeline for water risk and to identify the specific sectors in which improvements should be prioritized.

Currently, limited disclosures, non-standardized data, and the challenges of quantifying the added value of some performance indicators, such as partnerships, undermine fully informed decisions. Bloomberg LP is developing data analytics to improve the quality of corporate water use disclosures and to standardize data reporting. In particular, Bloomberg LP is supporting the Sustainability Accounting Standards Board (SASB) as it advocates for mandated environment social governance (ESG) disclosure in standard filings to the Securities and Exchange Commission. Ultimately, the purpose behind the drive for more and better data is to accelerate the incorporation of data analyses, including water risk data analyses, into investment decisions.

Nevertheless, within the financial community, water risk has a minimal impact on investment decisions. Though integrated within asset management divisions, water is generally only one or two metrics within a multi-metric portfolio. Even if the ESG matrix is used to assess an investment's value, it is but one data point aggregated with many other data points.

Increasingly, both companies and investors assess physical conditions in their decision-making process and local water conditions and future forecasts influence site location decisions. In reference to these conditions and forecasts, one forum participant commented, "If Arizona were a stock, you would short it." One intangible that can serve to differentiate investment opportunities is company engagement with stakeholders in the watershed, and the potential advantage these companies may gain by helping manage risk over time.

Water Utility perspective

On the whole, water utilities are affected by, rather than have the ability to affect, land use planning.

As the entities most directly tasked with supplying water to users, water utilities are keenly aware of the risks pertaining to water supplies. Water utilities are challenged to be able to provide sustainable water supplies 100 years from now, particularly given that they frequently remain disconnected from two significant threats to these supplies: land use planning and climate change.

Politicians frequently want growth, but too often that growth does not reflect a water utility perspective. Although land use planning significantly affects watersheds, water interests are typically not represented in land use planning decisions. As one

utility director noted, developers are granted permission to build and water utilities are expected to meet demand. Recently, water management has been used as a tool in permitting new development in communities with limited water supplies. Developers have been able to fast track permitting, if they incorporate water conservation, reuse, and recycling on site. However, on the whole, water utilities are affected by, rather than have the ability to affect, land use planning.

Climate change creates uncertainty, and leading utilities have begun addressing this uncertainty by moving beyond traditional decision-making practices to scenario planning for a range of potential futures. How climate change will affect the almost infinite range of water utilities in the United States remains unknown; we have yet to fully understand the magnitude of snowpack loss in the Sierra Nevada Mountains, the changes in flood frequency on the Mississippi River, or the effect of slightly warmer water temperatures on pathogens and water treatment by-products. Almost every utility will be faced with rapidly changing circumstances and the need to quickly adapt their management approaches as the ramifications of climate change become a reality. This challenge will require a new approach to permitting and regulation, over the static structures of the past.

U.S. WATER INNOVATIONS

INNOVATIONS IN WATER FINANCE

The projected price tag to bring water and wastewater systems up to date in the United States is approximately $1 trillion over the next 20 years. Given the magnitude of need, there is no shortage of financial capital eager to enter the sector. But significant misunderstandings choke the flow of capital. The financial tools and structures for financing water projects exist, but the lack of funding streams to repay the debt create a bottleneck, given that water rates do not cover costs.

Historically, U.S. water infrastructure was paid for with large federal grants and, later, state revolving funds; that is, grants have typically been a significant source of funding for water systems. Possibly the single greatest impact of the series of federal water pollution control acts (which included the 1972 Clean Water Act) was the steady stream of finance delivered to local water and wastewater utilities. Although federal funding is now largely reduced, and despite few expectations that it will ever return to previous levels, many utilities are delaying projects in hopes of securing grants or low-cost, subsidized capital—this while infrastructure deteriorates and construction costs increase.

Filling the funding gap will require a combination of private sector funding, public-private partnerships, increased user rates, alternative revenue streams from, for instance, producing energy from wastewater, and other novel approaches. Underlying many of these options is the need to raise awareness of the full cost of water services empowering decision makers and policy makers with the political will to make the necessary investments.

The majority of current funding comes from rate payers, yet rates do not cover the full cost of maintaining services and networks or of meeting new requirements and demand. Rates need to increase to cover the cost of operations, planning, emergent risk prevention, and future system capital expenditures. Yet it is difficult to quantify the savings from minimizing risk and investing in watershed health. Rate structuring and prices need to be insulated from the political process, but as the recent crisis in Detroit has shown, water rates can become deeply embroiled in politics.

Public-private partnerships in the U.S. water market have struggled to be adopted at scale, and though they are not viable under all conditions, they are viewed as one key funding avenue that needs to be considered. Recent partnerships in Rialto, California, Bayonne, New Jersey, and Middletown, Pennsylvania, have re-energized the push for partnerships. Such partnerships improve services for ratepayers through the influx of upfront capital for system upgrades and maintenance and the operational value that the private sector can bring to the partnership (such as economies of scale, technology efficiencies, additional research and development capacity, and willingness to take on operational risks).

Filling the funding gap will require a combination of private sector funding, public-private partnerships, increased user rates, alternative revenue streams from, for instance, producing energy from wastewater, and other novel approaches.

If there are to be more such partnerships, distrust between public sector and private sector stakeholders will need to be countered by mutual understanding of each other's operation, motives and interests, addition of value, and willingness to take on risk.

The allocation of risks and rewards is a contentious area in financing, particularly so in public-private arrangements concerning water. Access to adequate and high-quality drinking water is a public health and safety issue. While the public sector can allocate operational and performance risk to the private sector through these partnerships, public officials question the notion of sharing reputational risk, noting that public agents could be held responsible and suffer a long-term negative reputation for disasters caused by private firms. The firms' reputations, on the other hand, may be less permanently affected.

As water demand outpaces supply for agriculture, cities, industry, and the environment, opportunities for innovative funding are arising. For example, investment in green infrastructure that maximizes watershed recharge in a densely populated area could potentially increase a developer's investment rating and thus lower the cost of capital. In the agriculture sector, innovative funding mechanisms include compensation to farmers for their water rights ("water as a crop") or payments for upgrades that would improve water use efficiency.

INNOVATIONS IN WATER TECHNOLOGY

Innovations in water technology are in development to improve water systems' monitoring and data management, efficiency, treatment, and infrastructure. Of all the developments in water sustainability, these innovations may have the greatest potential to be game changers.

Data management

One of the key developments of the past decade has been the increasingly wide availability of data, including high spatial and temporal resolution data as well as real-time data. Widespread sensor networks, new and existing satellite platforms, and the potential for crowd-sourced data have put water fully into the realm of big data. The provocative question now is whether increasing the capacity to measure and model a region's, city's, or utility's water budget—that is, to quantify how much water from soil moisture and groundwater enters water storage reservoirs, water mains, and wastewater treatment transmission lines—could change management strategy. This topic is further addressed in the following section under "Priorities for the U.S. Water Sector."

Widespread sensor networks, new and existing satellite platforms, and the potential for crowd-sourced data have put water fully into the realm of big data.

Wastewater and reuse

Both industry and municipalities are driving innovation in wastewater treatment and reuse technologies to address demands for energy, finite minerals and nutrients, and water supply. New technologies seek to not only reduce energy used for plant operations but also to capture energy from the organic materials in wastewater. The energy in wastewater is ten times the energy needed to treat the water, and could generate, rather than consume, energy.

Solids in wastewater are increasingly viewed as a revenue stream rather than as a disposal cost. As one forum participant said, "Perhaps wastewater should be called 'rich water.'" Currently, only about 5% of global wastewater is reused, and though existing technology is promising, further advances and refinements are necessary to take maximum advantage of energy in wastewater. To set themselves apart in water reuse, some companies seek to clean the most contaminated wastewater to the highest-quality standards and to recover the minerals, nutrients, and other resources therein.

Water quality sensors

Water quality sensors have changed dramatically over the last few years, and the cost per device has substantially dropped. Just how close the technology is to being accurate and inexpensive enough to be widely used is unclear. But as sensors become more accurate and available, more data will be generated, increasing the viability of water quality trading that is dependent on accurate measurement.

The Energy-Water Nexus: Integrating water and energy utilities

Conventional electricity generation is a significant consumer of water for steam production and cooling, with a typical coal plant consuming one to four billion gallons of water drawn from nearby water sources.[1] At the same time, thermoelectric power, producing most of our electricity, accounts for approximately 49% of the water withdrawn in the United States each year.[2] Renewable electricity generation can significantly reduce the water demand associated with conventional electricity generation. However, the variability associated with wind and solar-sourced electricity can add challenge to operating the stable electric grid and providing reliable electric service to consumers.

Emerging technologies and practices may allow co-optimized operation of electric grids and water supply systems in ways which can provide value to both. For example, water utilities could time their treatment runs to the availability of renewable energy, so as to increase the capacity factor and economics of the renewable resource and avoid the need by the energy utility for additional investment in peak generation while reducing the cost and carbon footprint of the water utility's operations. At a larger scale, the operating authorities for energy and water grids could coordinate their activities for optimal effect: one participant noted "it is easier to store water than to store electrons, but it is easier to move electrons than it is to move water". The National Renewable Energy Laboratory's Energy System's Integration Facility (ESIF) is developing a testbed for the conduct of this research.

Pumped storage is one of the viable options available for addressing both water use and sustainable renewable energy production. This approach offers rechargeable energy generation and storage capacity, by addressing the need for renewable energy on days with little sun or wind (when water can be released to lower altitudes through turbines to produce the needed electricity), and the need for storage at times with high wind or sun availability but low demand (when water is pumped to higher altitude reservoirs for storage). This approach will play an increasing role in developing sustainable energy systems at scale while diminishing the water use intensity of conventional energy generation.

1 "Environmental Impacts of Coal Power: Water Use." Union of Concerned Scientists. Online: http://www.ucsusa.org/clean_energy/coalvswind/c02b.html

2 "Thermoelectric Power Water Use." The USGS Water Science School. Online: http://water.usgs.gov/edu/wupt.html.

PRIORITIES FOR THE U.S. WATER SECTOR

DISSEMINATING AND SCALING INNOVATIVE MANAGEMENT PRACTICES

Water managers at large municipal utilities are leading the way in developing and testing innovations. DC Water, for example, has focused on building a widely recognized and respected public brand while merging green and gray infrastructure with climate change in mind. Philadelphia Water is taking on issues outside of its traditional purview, such as the quality of water in waterways, climate change impacts on water temperature, sea level rise, and city planning. Cincinnati Water is working at the cutting edge of information technology to integrate all data sources for robust analyses. Denver Water has developed relationships with local industry while integrating land use planning with water management, and it has been proactive and diligent in assessing the potential impacts of climate change. San Francisco's Public Utility Commission has demonstrated the importance of technology by enabling clients to access up-to-date water use statistics and by joining with the National Aeronautics and Space Administration (NASA) to use remote sensing to inform water management decisions. Los Angeles' Bureau of Sanitation is a leader in stormwater management, seeking to create valued public spaces that serve the dual purposes of stormwater management and neighborhood recreation.

Better connecting the 50,000 distinct U.S. water utilities will allow better use of what are essentially high-risk, high-reward approaches that the larger utilities have felt compelled to adopt.

These water utilities have become trail-blazers. Their stories should be celebrated and lessons shared with the country's tens of thousands of other water utilities. The federal government, along with state governments, could take on that role by serving as an information clearinghouse and disseminator of best practices. This effort could be modeled on the Canadian government's Networks of Centers of Excellence, which support experts from academia, government, industry, and communities working together to solve problems and apply homegrown research and breakthrough ideas to increase Canada's competitiveness and prosperity.

Better connecting the 50,000 distinct U.S. water utilities will allow better use of what are essentially high-risk, high-reward approaches that the larger utilities have felt compelled to adopt. Smaller utilities—which comprise most of the 50,000 U.S. utilities—generally have few resources to innovate, and even fewer resources to do in-house research. Translating lessons from one scale to another is both an enormous opportunity and a formidable challenge.

WATER SECTOR LEADERSHIP FOR RESILIENCE

The water sector should focus on resilience as a framework for water protection in the face of climate change and other emerging challenges. This requires the sector to take on a leadership role in the areas of river and stream ecology, ecosystems, flooding, land use and city planning, climate change, and food and energy production.

The different water source authorities—whether at the national, state, or local level—are spread across numerous agencies with varying degrees of communication, tolerance for regulatory compliance, and acceptance of innovation.

Obstacles to taking a leadership role

One obstacle to the water sector's effectiveness in leading resiliency strategy and implementation is outdated water policies. These policies are largely governed by the Clean Water Act, the Safe Drinking Water Act, and state water right laws, which served the nation well in the 20th century but which now must be reevaluated and updated, to account for growing pressures on our water systems from increased use, aging infrastructure, and pollution.

Another obstacle is fragmentation in management of different water sources, which undermines comprehensive planning and is inefficient. Groundwater, surface water, stormwater, recycled water, and reused water all need to be integrated and thought of as a single water system. Frequently, water source authorities—whether at the national, state, or local level—are spread across numerous agencies with varying degrees of communication, tolerance for regulatory compliance, and acceptance of innovation. These groups are difficult to gather at one table, yet once together can identify important synergies. Funding to convene such groups could significantly benefit attempts to integrate water management and build resilience.

Green infrastructure and stormwater management

One of the most significant ways in which the water sector can enhance resilience is to incorporate innovations into green infrastructure, particularly stormwater management, and financing such projects with green bonds, public-private partnerships,

or pay-for-performance models. In this effort, it has the support of the EPA. Eager to encourage green infrastructure where optimal, the agency is attempting to be flexible within the constraints of the Clean Water Act while working to ensure that green infrastructure can meet compliance requirements.

The water sector's capacity to scale up green infrastructure is challenged by a lack of understanding of that infrastructure's actual costs and benefits. Although not widely admitted, the cost of green infrastructure is still frequently greater than that of traditional gray infrastructure, though it will likely drop with the development of tools that make green infrastructure an "off the rack" option.

As a city evolves and new infrastructure projects are initiated, incorporating green infrastructure can have value; however, it is as yet not cost-effective to incorporate green infrastructure for the sake of stormwater management alone. If recognized, additional benefits like recreation, open space, and wildlife habitat can change the equation, although potentially currently not enough to offset the cost certainty associated with traditional gray infrastructure.

INNOVATIVE WATER MANAGEMENT IN LOS ANGELES

Photo courtesy of Kansas Sebastian @flickr

Los Angeles has made stormwater management a priority to address its limited rainfall and to be prepared for the occasional flood event. In one case, initial water management plans were rebuffed by area communities, until stormwater green infrastructure was introduced as an accessible park. Building stakeholder support has been central to the successful implementation across Los Angeles' water initiatives.

GENERATING AWARENESS AROUND THE VALUE-OF-WATER

Water services in the United States are, quite simply, not adequately valued by the public. At the same time, charging full cost for water services is untenable for many consumers, and so those who set rates face considerable vocal opposition when attempting to address revenue shortfalls by raising consumer cost. Rates incommensurate with services diminish available capital and financing options, curtailing maintenance and undermining development of state-of-the-art systems. Undervalued water also stymies potential advances in water technologies because it discourages financing for innovations perceived to have a limited return on investment. Additionally, until

water services are perceived to be of greater value, it will remain difficult to justify or incentivize conservation of any sort; guilt is only a good short-term motivator.

To shift public attitudes, the water industry needs to promote the value of water for all its many purposes and help customers to understand that they are paying not only for the water from their tap but also for treatment and delivery systems providing unlimited safe drinking water. Awareness must be generated of the range of benefits that this system delivers: protected watersheds, maintained infrastructure, capacity to support future growth and meet other new demands, and resilience to disasters. Finally, the public must be informed of the connection of water management to issues outside the purview of water managers. These issues include energy production, food production, land use planning, and waterway restoration and protection, all of which are highly dependent on reliable access to water and have a significant impact on water management.

To shift public attitudes, the water industry needs to promote the value of water for all its many purposes and help customers to understand that they are paying not only for the water from their tap but also for treatment and delivery systems providing unlimited safe drinking water.

Steps to raise awareness around the value-of-water should also target political leaders, CEOs, CFOs, and other decision makers outside of the water industry. Calculating likely financial costs of inaction is one way to generate their support. Such support might also drive additional funding toward new water technologies. The higher value given to water, the greater the opportunity for a return on that investment.

Water utilities can support such an effort by focusing on raising their public profiles, developing brands, and providing the opportunity for customers to connect with their utilities through social media and local events. As one utility leader put it, "We fight for customers as if we were Nike."

The burgeoning **Value of Water Coalition,** composed of private industries and public utilities, might offer the opportunity for the water industry to build public awareness and cross-industry collaboration. Raising the profile of water and building a constituency that values the real cost of access to it will increase the amount that users are willing to pay for that access. Augmented funding will attract more financing. The availability of more capital will enable the water sector to make the significant changes necessary to ensure a sustainable water future that benefits both people and the environment.

THE VALUE OF WATER COALITION

The **Value of Water Coalition**, comprised of public and private sector representatives from the water industry, aims to educate the public on "clean, safe, and reliable water" in the context of increasingly threatened water infrastructure nationwide. Their efforts include webcasts, blogs, news and information sharing online and newsletters.

www.thevalueofwater.org

DATA INTEGRATION

In an age of increased monitoring and information, our lack of knowledge about the amount of water available throughout the water system is perplexing. As one forum participant remarked, "In a place where water is like oil, the fact that California does not have its own system for accounting for all the water it uses, transports, and produces should be a real wakeup call." Development of an integrated national water accounting system to define and monitor the country's water budget should be a priority.

The lack of coherence to the vast amount of data available presents opportunities and challenges. Extensive amounts of spatial and temporal data pertaining to water management are collected at levels ranging from the household to the watershed to the atmosphere. "We are awash in data," said one forum participant. "But we need intelligence."

Development of an integrated national water accounting system to define and monitor the country's water budget should be a priority.

It is imperative that water flow and access data are compatible and that they give rise to analytics that can help decision makers manage water in real time. High cost, privacy concerns, and the multitude of vested stakeholders will prove challenging. These stakeholders include the federal government (U.S. Department of Energy, U.S. Department of Interior, U.S. Geological Survey, Environmental Protection Agency, U.S. Department of Agriculture, NASA, the National Oceanic and Atmospheric Administration, and other agencies), state governments and their comparable departments, local governments and utilities, water users, researchers, and NGOs. Given so many interests, a key need is identifying the agency to compile, streamline, and maintain the relevant data sets, while ensuring that they are accessible to relevant stakeholders—a task similar to that taken on by the USGS in managing the U.S. stream gauge network and in sustaining and maintaining the databases supporting it.

Some private companies have seized the opportunity to combine data into coherent platforms, but vast niches of data and analytics remain unaddressed. The potential users (i.e., purchasers) of these data, from the agricultural sector to the industrial sector to utilities, are numerous.

At a local scale, water utilities are already developing water accounting systems, aided by cloud computing and wireless technologies that ease data input. Smart water grid systems can track, monitor, and manage systems in near-real time, identifying leaks and encouraging people to use water more efficiently. San Francisco water users now have access to mobile software that tracks personal water use and allows users to compare themselves to friends, neighbors, and other customers. Cincinnati Water has requested that vendors collaborate with the utility to standardize data sets, to ensure that the many sources of data are compatible.

Because of both legal ramifications and privacy concerns around data, some resistance to information sharing continues. Data on groundwater withdrawals can be particularly challenging to obtain; in fact, some states' laws prevent customers from reporting water withdrawal quantities. Also challenging will be building the trust of the agriculture community. Whether a federal agency or private industry should be able to distribute water use data at the individual plot level—which could include the individual suburban household level—is a provocative question.

To overcome these obstacles to information sharing, the water sector must demonstrate that water intelligence benefits customers by improving their service.

FEDERAL-STATE-LOCAL TENSIONS

Two years ago, on the 40th anniversary of the Clean Water Act, numerous conferences explored whether a new Clean Water Act was needed. Potential expansion of the act's federal jurisdiction provoked considerable controversy.

While some suggest that efforts be made to advance a new national policy agenda, others have little interest in seeing the federal government take a leadership role as it had done throughout the mid-20th century in terms of infrastructure (Bureau of Reclamation, Corps of Engineers), finance (Clean Water Act finance of municipal infrastructure), or policy (Clean Water Act, Safe Drinking Water Act, Endangered Species Act). Many industry representatives believe that local entities and private industries are the true facilitators of new policies (for example, Chesapeake Water Quality Trading Program), new finance models (for example, DC Water's 100-year "green bond"), and new technology.

Others see a dual role for federal and state policy to drive innovation by providing regulations that allow flexibility in compliance approaches along with opportunities

for local solutions. As these solutions emerge, state and federal authorities need to find a way to seize high-potential policy opportunities and to then disseminate and scale the most effective and efficient ideas.

At the same time, some interest exists in the federal government assuming a role in facilitating new finance models. One such funding mechanism is the Water Infrastructure and Innovation Authority (WIFIA), modeled on the Transportation Infrastructure Finance and Innovation Act. WIFIA was enacted in the month following the forum as part of the Water Resources Reform and Development Act, and authorizes the EPA and Army Corps of Engineers to each offer $175 million in low-interest loans for water and wastewater infrastructure projects. This federal credit assistance is expected to have a 10:1 leverage ratio, potentially generating $3.5 billion worth of loans in the next five years. Such federal funding reduces financial costs and spurs local infrastructure projects to fix and expand water systems. Another reform mentioned to increase financing and to close the infrastructure gap was to remove the volume cap on private activity bonds. Currently, such a change has little traction in Congress.

State and federal authorities need to find a way to "say yes" to new opportunities and then to help disseminate, translate, and scale the effective and efficient ideas.

The timescale of private-sector investments are asymmetric to the timescale of technology development: funding is available for short-term (e.g., three-years) loans and for long-term loans but less so for the five- to seven-year loans that allow new technologies to time to develop. Although the federal government could help drive water technology innovations, it has not actively worked alongside private industry and state and local governments to facilitate them. The water industry receives considerable funding for research and development from governments overseas and little funding from the U.S. government; however, the federal government could play an essential role in overcoming financial barriers to technology innovation with greater investment.

One key effort for the different levels government to engage in and cooperate on is the development of multi-scaled data platforms. Each makes an important contribution, but collaborative action has been a challenge. The federal government must play some role in facilitating water data management because many of the existing and proposed data sources are federal sources (for example, NASA satellites, USGS stream gauge network). At present, state agencies often maintain—if not always compile—water quality data. Local governments might have data on water use and can best engage and build trust with water users reticent to share information.

A model for engagement is the approaches of watershed and river basin commissions (for example, the Delaware River Basin Commission), which have played central roles in data collection and maintenance. These should be looked to as strong examples of successful data collection and dissemination.

CONCLUSION

Despite persistent warnings from the water industry and others of imminent water crises, the public and the federal government continue to undervalue water as a resource. Frustration has mounted as a challenged water sector looks for the expected public outcry to meet looming challenges faced by a U.S. water system already strained by the droughts in the West and Southwest and the aging and underfunded infrastructure of the East Coast. Badly needed innovations in finance and technology remain underutilized, stymied by the status quo and structures that were adopted during periods of challenges and priorities quite different from those of today.

While neither expeditious nor widespread, advances in water management are encouraging. A game changer would be a water accounting system and the management of all water as a single resource within a watershed. Paving the way toward this future are data from myriad sources. But if they are to be used by decision makers, these data need to be made compatible and need to be further analyzed and disseminated.

A growing number of partnerships encourage the water industry and major water users to undertake a collaborative, watershed-wide approach to water management; to adopt advances in management techniques and technologies; and to widely disseminate information and resources. These partnerships recognize that a resilient and world-class water system will require an enthusiastic and supportive public.

Forums such as the Aspen-Nicholas Water Forum are an important piece of the process that provide space for diverse and visionary thinkers to collaborate and pave the way toward a transformed, world-class U.S. water system. Government at all levels, along with water utilities and major water users, must now join forces to better define the value of water, and to increase our national perception of, and appreciation for, the tenuousness of the water access we now take for granted.

APPENDIX I: RELEVANT RESOURCES & INITIATIVES

Alliance for Water Efficiency
www.allianceforwaterefficiency.org

CEO Water Mandate
http://ceowatermandate.org

Carbon Disclosure Project Water Program
https://www.cdp.net/water

Ceres
http://www.ceres.org/issues/water

Circle of Blue
www.circleofblue.org/waternews

Growing Blue
http://growingblue.com

National Association of Clean Water Agencies (NACWA)
www.nacwa.org

Nicholas Institute for Environmental Policy Solutions
http://nicholasinstitute.duke.edu/water

Pacific Institute
http://pacinst.org

U.S. Department of Interior
www.doi.gov/whatwedo/water/index.cfm

U.S. Environmental Protection Agency
http://water.epa.gov

U.S. Geological Survey
www.usgs.gov/water

U.S. Water Alliance
www.uswateralliance.org

U.S. Water Partnership
http://uswaterpartnership.org

Value of Water Coalition
http://thevalueofwater.org

Water Environment Federation (WEF)
www.wef.org

Water Environment Research Foundation (WERF)
www.werf.org

Water Technology
www.watertechonline.com

World Resources Institute: Aqueduct Measuring and Mapping Water Risk
www.wri.org/our-work/project/aqueduct

APPENDIX II: FORUM AGENDA

THURSDAY, MAY 29

9:00 – 9:15 AM

Introductions, Purpose and Process
A brief introduction from the hosts regarding the genesis and hopes for this convening, including ground rules for Aspen-style forums. Each session will begin with brief remarks from select participants with the majority of time set aside for moderated discussion among all.

David Monsma, the Aspen Institute
Tim Profeta, Nicholas Institute

9:15 – 10:45 AM

Session One: The State of Water in the U.S.
If nothing changes, what are the prospects for water resources in the U.S. in the year 2050? Regions face similar as well as distinct water challenges related to climate change, degraded ecosystems, declining groundwater, growing demand, and aging infrastructure. This session will immerse us in these challenges to stimulate a rich discussion on the necessary game changers leading toward a sustainable water future.

Moderator: **David Monsma**, the Aspen Institute

Discussants:

National Scale Trajectory and Water in 2050	**Martin Doyle,** Nicholas Institute
The West	**Tom Iseman**, U.S. Department of Interior
The Southeast	**Bill Holman,** North Carolina Conservation Fund
The Northeast	**George Hawkins**, DC Water

11:00 – 12:30 PM

Session Two: Water Use and Risk
Stagnation of water management practices creates nascent risk for businesses while affecting the economic stability of cities, states and entire regions. This session will examine emerging water risks for different sectors from the water industry itself to agriculture, manufacturing, and energy and explore how the public and private sectors are implementing strategies to create a future of sustainable water resources. Underlying this recognition of risk is the chronic, sustained loss of natural ecosystems if environmental risk is not factored in as an equal part of water management.

Moderator: **Martin Doyle**, Nicholas Institute

Discussants:

Water Providers	**Jim Lochhead**, Denver Water
Manufacturing	**Tom Cooper**, Intel
Energy Sector	**Su Gao,** Bloomberg LP
Corporate Water Stewardship	**Will Sarni**, Deloitte Consulting LLP

2:00 – 3:30 PM

Session Three: Innovation in Water Policy

Getting policy right can be instrumental in altering trajectories from the status quo. Policy stability creates regulatory certainty for businesses; and, vice versa, changes in policy may be necessary to trigger innovations in technology, management, and finance. This session will explore water policy innovations with elected officials and regulators from the local and regional level to the state and federal level. What conditions allow innovation to flourish; what policies need to be updated to keep pace with changing conditions; and what lessons can be learned and shared from local-scaled policy innovations?

***Moderator*: Tim Profeta**, Nicholas Institute

***Discussants*:**

Federal	**Nancy Stoner**, EPA
States	**Felicia Marcus**, California Water Resources Control Board
Cities	**Howard Neukrug**, Philadelphia Water Department
Cross-border	**Margaret Bowman**, Walton Family Foundation

3:45 – 5:15 PM

Session Four: Innovation in Water Finance

Payment as usual is not going to finance a water system of the future that satisfies a growing population, supports economic growth, sustains or even restores environmental quality, and responds to unforeseen future conditions. Historic underpricing of water has resulted in indifference toward conservation and the undermining of long-term investments in water technology and infrastructure. This session will consider financing structures that are necessary to build infrastructure, respond to an evolving economy dependent on water, support technological innovations, and use water most efficiently.

***Moderator*: Debra Coy**, Svanda and Coy

***Discussants*:**

Investing in Water	**Disque Deane**, Water Asset Management
(P3) Financing	**Tim Romer,** Goldman Sachs
Paying for Water	**Michael Deane**, National Association of Water Companies

FRIDAY, MAY 30

9:00 – 10:30 AM

Session Five: Innovation in Water Technology

While innovations in new and existing water technologies show great potential to significantly address existing and emerging challenges, adoption, interconnection and financing are lagging. This session will explore some of these potential "game changing" technologies, and consider important linkages and systematic impacts upstream and downstream. Conversely, what barriers limit technology innovations and commercialization and how can they be overcome?

***Moderator*: Martin Doyle**, Nicholas Institute

***Discussants*:**

Emerging Technologies	**Jon Freedman**, GE
Monitoring and Mapping	**Steve Kopp**, ESRI
Energy-Water System Integration	**Bryan Hannegan**, NREL

10:45 – 12:15 PM

Session 6: Optimizing Green & Gray Infrastructure on the Path to Resilience

Visionary thinking is needed as cities plan and (re)-build for a future that bolsters sustainable growth yet is resilient to extreme events, whether climate or financial. With the growth of regulatory demands on water systems, particularly stormwater, can natural ecosystem "green infrastructure" be used to meet demands more efficiently than traditional "gray infrastructure?" Is there sufficient certainty of ecosystem services to offset known services of gray infrastructure and are ecosystems financeable under current regulatory constraints? Are they more or less adaptable to changing conditions, from climate change to novel contaminants? How should the built and natural environments co-exist on the path to resiliency?

***Moderator*: Gordon Binder**, World Wildlife Fund

***Discussants*:**

The Case for Natural Infrastructure	**Todd Gartner,** World Resources Institute
Storm Water Management Innovation	**Adel Hagekhalil,** Los Angeles Bureau of Sanitation
Building Resilience at Scale	**Jay Jensen**, Council on Environmental Quality

1:30 – 3:30 PM

Session 7: Where Do We Go From Here?

Collective approaches and actions are gaining traction as recognition grows that good water stewardship requires mobilizing diverse institutions and economic sectors and partners. What are the key insights and take away messages from this Forum? Which topics are ripe for more focused consideration? Are there key insights that this diverse group should collectively put its weight behind?

David Monsma, the Aspen Institute
Tim Profeta, Nicholas Institute

APPENDIX III: FORUM PARTICIPANTS

THE ASPEN-NICHOLAS WATER FORUM

Aspen, Colorado
May 28-30, 2014

Gordon Binder
Senior Fellow
World Wildlife Fund

Margaret Bowman
Acting Environment Program Director
Walton Family Foundation

Alan Boyce
Chairman and Co-Founder
Materra LLC

Christine Boyle
President
Valor Water Analytics

Patrick Cairo
SVP, Corporate Development
United Water

Michael Carlin
Deputy General Manager and COO
San Francisco Public Utilities Commission

Tom Cooper
Corporate Water Programs Manager
Intel Corporation

Debra Coy
Principal
Svanda and Coy Consulting

Glen Daigger
President, International Water Association
SVP and CTO
CH2M Hill

Stu Dalheim
VP, Shareholder Advocacy
Calvert Investments

Disque Deane, Jr.
CIO and Co-Founder
Water Asset Management

Michael Deane
Executive Director
National Association of Water Companies

Martin Doyle
Director, Water Policy Program
Nicholas Institute for Environmental Policy Solutions, Duke University

Ralph Exton
Chief Marketing Officer
GE Water & Process Technologies

Brent Fewell
Partner, Troutman Sanders LLP
Board of Directors
US Water Alliance

Jon Freedman
Vice President, Government Affairs
GE Water 2

Paul Freedman
President and CEO, LimnoTech
Former President
Water Environment Federation

Su Gao
Senior ESG Analyst
Bloomberg LP

Todd Gartner
Senior Associate
Food, Forests & Water Program
World Resources Institute

Biju George
Deputy Director
Metropolitan Sewer District of
Greater Cincinnati

Peter Grevatt
Director, Office of Ground Water
and Drinking Water
U.S. Environmental Protection Agency

Adel Hagekhalil
Assistant Director, Wastewater
Collection Systems and Operations
Watershed Protection
Bureau of Sanitation, City of Los Angeles

Bryan Hannegan
Associate Director, Energy Systems
Integration
National Renewable Energy Laboratory

Stephen Harper
Global Director, Environment and
Energy Policy
Intel Corporation

Marilu Hastings
Director, Sustainability Program
Cynthia and George Mitchell
Foundation

George Hawkins
General Manager
DC Water

David Holbrook
Environmental Engineer
National Institute of Standards and
Technology

Bill Holman
North Carolina Director
The Conservation Fund

Thomas Iseman
Deputy Assistant Secretary, Water and
Science
U.S. Department of the Interior

Ken Kirk
Executive Director
National Association of Clean Water
Agencies

Kelly Kopp
Chair, Board of Directors
Alliance for Water Efficiency

Steve Kopp
Program Manager, Spatial Analysis
ESRI

James Lochhead
CEO and Manager
Denver Water

Felicia Marcus
Chair
California State Water Resources Control
Board

Jim Marston
VP, US Climate and Energy
Environmental Defense Fund

Kevin Molloy
Vice President
CDM Smith

David Monsma
Executive Director
Energy and Environment Program
The Aspen Institute

Howard Neukrug
Commissioner and CEO
Philadelphia Water Department

Robin Newmark
Associate Laboratory Director
National Renewable Energy Laboratory

Arleen O'Donnell
Vice President, Natural Resource Management and State Support
Eastern Research Group, Inc.

Margaret Palmer
Professor and Director
National Socio-Environmental Synthesis Center

Chuck Podolak
Postdoctoral Research Associate,
Nicholas School
of the Environment, Duke University
2014-2015 AGU Congressional Science Fellow

Tim Profeta
Director, Nicholas Institute for
Environmental Policy Solutions
Duke University

Heather Quinley
Sustainability Director
Duke Energy

Timothy Romer
Managing Director, Head of
Western Region
Public Sector and Infrastructure Banking
Goldman Sachs

John Sabo
Director of Research Development
Julie Ann Wrigley Global Institute
of Sustainability
Arizona State University

Kelly Sanders
Assistant Professor of Civil
and Environmental Engineering
University of Southern California

William Sarni
Director and Practice Leader,
Enterprise Water Strategy
Deloitte Consulting LLP

Albert Slap
Senior Counsel
Biscayne Bay Waterkeeper

Brooke Smith
Executive Director
COMPASS

Kevin Smith
Vice President, Environmental Markets
Group Goldman Sachs

Raffael Stein
Director, Municipal Support Division
U.S. Environmental Protection Agency

Nancy Stoner
Acting Assistant Administrator
U.S. Environmental Protection Agency

Christopher Taylor
Executive Director
West Coast Infrastructure Exchange

Francisco Zamora
Director, Colorado River Delta Legacy Program
Sonoran Institute 4

RAPPORTEUR

Courtney Harrison
Policy Associate, Nicholas Institute for Environmental Policy Solutions, Duke University

Nicole Buckley
Senior Program Manager
Energy and Environment Program
The Aspen Institute

THE ASPEN INSTITUTE

Nicole Alexiev
Deputy Director
Energy and Environment Program
The Aspen Institute

Timothy Olson
Senior Project Manager
Energy and Environment Program
The Aspen Institute

Avonique DeVignes
Project Assistant
Energy and Environment Program
The Aspen Institute