

SUSTAINABLE WATER SYSTEMS:
STEP ONE - REDEFINING THE NATION'S
INFRASTRUCTURE CHALLENGE



THE ASPEN INSTITUTE
ENERGY AND ENVIRONMENT PROGRAM



A Report of the Aspen Institute's Dialogue on Sustainable Water Infrastructure in the US

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Sustainable Water Infrastructure in the U.S.



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Participants in the Aspen Institute's Dialogue on Sustainable Water Infrastructure in the U.S. participated as experts in their field and not in their professional capacity or organizational affiliation. As with all policy dialogues in the Aspen Institute's Energy and Environment program, the format followed the Institute's time-honored approach to intentional, values-based dialogue, and adhered to a strict not-for-attribution rule throughout the duration of the dialogue.

Meetings of The Dialogue on Sustainable Water Infrastructure in the U.S. were held at The Aspen Institute campus in Aspen, Colorado on May 21-24, 2008; September 10-13, 2008; and January 11-14, 2009 and at The Aspen Institute campus in Wye, Maryland on March 1-2, 2009.

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FOREWORD

America's drinking water and wastewater systems face increasing challenges in maintaining and replacing their pipes, treatment plants, and other critical infrastructure. Prolonging and renewing the nation's high-quality water services requires a clear sense of what is a sustainable water infrastructure, the amount of investment needed to create and preserve it, where investments should be made, and by whom. In 2008 and 2009 the Aspen Institute convened a multi-stakeholder dialogue to help provide clarity and promote leadership on these issues.

With few exceptions, everyone shares the goals of ensuring clean and safe drinking water for all communities, protecting the natural environment, and making certain that the nation's water infrastructure benefits from sustained investment. Keeping these shared values in the forefront of our Aspen Dialogue was essential as the group examined the subordinate issues on which positions differed. In this case, the shared values and differing positions led to new thinking about an expanded definition of water infrastructure, and by implication, what investments are needed to provide a more holistic approach to sustainable water infrastructure.

The Aspen Dialogue gave rise to a set of ten policy recommendations which were agreed to by all participants. The Aspen Institute wrote the text of the report, pulling language and insights from the richness of the discussion during four meetings over the course of a year. Members of the Aspen Dialogue listed in Appendix II participated as experts in their field, not as representatives of their organizations. While names and affiliations are listed for identification purposes, no person's participation should be assumed to imply his or her organization's endorsement of any specific finding or recommendation. Each person listed consented to having their name associated with this report although the dialogue also benefited from the involvement of some individuals who ultimately decided not to be listed.

Aspen Institute reports, because of the diverse voices that contribute to them, rarely reflect all of the desires of any one constituency, and therefore each participant may feel as though something critical, in their perspective, is missing. This is not uncommon. Nor is it uncommon that the full suite of potential topics associated with a particular issue cannot be addressed, which was also the case in this dialogue.

This report, while taking a hard and new look at the definition of water infrastructure, does not exhaust the dialogue needed to address the important issues of sustainable infrastructure funding or gaps thereto. Most notably, we did not reach consensus on issues regarding which funding mechanisms are appropriate to finance a modern view of water infrastructure, including the utility of a federal trust fund. Undoubtedly, more discussion beyond this report is warranted.

What is obvious is that the Aspen Dialogue was a preliminary step toward a fuller discussion and dialogue around how to implement a sustainable water infrastructure. Its real discovery was a broader, contemporary understanding of a sustainable water infrastructure for the nation. This final report is an important and timely contribution to the water infrastructure debate in this country. While not comprehensive, it does establish a basis for informing legislative or regulatory action at any scale.

Ray Bolger served as Rapporteur for the dialogue, skillfully extracting the major themes and illustrative points from a wealth of excellent presentations and complicated discussions. Administrative preparations and dialogue support were admirably handled by Regan Nelson. Her hard work and attention to detail as Project Manager were responsible for a pleasant and smoothly run dialogue. Along with the participants, I am grateful for this conscientious effort. Finally, the dialogue benefitted immensely from the skilled co-moderation provided by Connie Lewis, whose insights and commitment to finding common ground helped to advance all aspects of the dialogue.

The Aspen Institute would like to thank the Water Environment Federation (WEF), the National Association of Water Companies (NAWC) and CH2M HILL for their generous support of this dialogue. Without their commitment and generosity, the dialogue could not have taken place. Lastly, in memoriam, we note with sorrow the loss of Peter Cook, the Executive Director of NAWC.

David Monsma
Executive Director
Energy and Environment Program
The Aspen Institute
May 5, 2009

RECOMMENDATIONS IN BRIEF

1. The water management and policy community must redefine “water infrastructure” as one that integrates built infrastructure components with the protection and restoration of its supporting natural watershed infrastructure and the use of emerging small-scale water technologies and water management solutions.
2. Watershed-oriented entities, at scales and compositions appropriate to local conditions, should manage the redefined water infrastructure according to the principles of the Sustainable Path. These entities should foster collaboration, cooperation and integration between utilities and agencies to provide water, wastewater and stormwater services, achieve sustainable management of surface and groundwater resources, and ensure environmental protection and enhancement.
3. Federal, state and local officials should adopt watershed-oriented policies and regulations that incorporate the principles of the Sustainable Path into funding decisions. Resource management entities and water utilities should adopt the Sustainable Path principles in their operations and administration.
4. Water utilities must lead in building partnerships that will use integrated water resource planning and management as a principal tool for preserving and restoring water resources while meeting human and ecosystem needs for water in the context of a changing climate.
5. Federal, state and local governments and other entities should find ways to remove or modify institutional barriers and practices that impede or prevent sustainable water resource management according to the principles of the Sustainable Path, and should actively address all sources of pollution, degradation and depletion on a watershed basis.

6. Utility and system managers as well as regulators and governing boards should ensure that the price of water services fairly charges ratepayers or customers the total cost of meeting service and sustainable water infrastructure requirements, subject to concerns about affordability. Funding for water utilities should generally rely on cost-based rates and charges, and water revenues should not be diverted to unrelated purposes.
7. Water utilities should employ a variety of practices on the path to sustainability, including: transparency in governance and operation; public outreach and consultation; integrated water management; asset management; workforce management; conservation and efficiency (both water and energy); advanced procurement and project delivery methods; adaptation to and mitigation of climate change; research and development; and technological and managerial innovation.
8. Federal and state agencies and water utilities should provide assistance to water service systems – especially small systems – to improve their financial, managerial, technical and planning capacity to implement all the elements of the Sustainable Path.
9. The federal government shares the responsibility for achieving the Sustainable Path. Therefore, federal funding should target investments in 21st century priorities, including “green infrastructure;” water and energy efficiency; climate change adaptation; clean and safe water for economically distressed households; research, development and demonstration projects for integrated water management; and incentives for sustainable utilities.
10. Water utilities should apply appropriate practices to assist low-income customers. Federal and state funding agencies should direct affordability support principally towards households in need, except where community-level assistance is effective and efficient.

EXECUTIVE SUMMARY

During the past 150 years, a complex water infrastructure has been built throughout the U.S. to supply homes and businesses with clean water, collect and treat wastewater and manage stormwater – and an equally complex regulatory system has evolved alongside it. A generation of progress has been made under the Clean Water Act and the Safe Drinking Water Act. However, serious challenges still exist for the nation’s freshwater resources, including insufficient progress in achieving water quality goals, overuse of water resources, and looming challenges associated with global climate change, including droughts, heavy storm events and flooding. Meanwhile, water and wastewater utilities are struggling with aged infrastructure that requires upgrades or replacement. Control of urban stormwater and rural runoff will require large new investments. Appropriate sources of funding and affordability of these investments also requires attention.

It was in this context that the Aspen Institute convened the Dialogue on Sustainable Water Infrastructure in the U.S., bringing together distinguished leaders from the water utility industry; federal, state and local government regulators; and non-profit environmental groups to develop policy recommendations that address water infrastructure planning and management challenges for the coming decades. Between May 2008 and March 2009, participants in the dialogue met on four separate occasions, employing their broad range of expertise to peel back the layers of complexity surrounding our nation’s water resources.

In keeping with the mission of the Aspen Institute to foster enlightened leadership and open-minded dialogue, this diverse group explored the sometimes competing values that underlie water infrastructure planning, management and financing. While a system so complex and vital to all of society necessarily involves certain points of friction, the dialogue participants jointly developed and adopted **10 KEY POLICY RECOMMENDATIONS** for a sustainable water infrastructure. Taken as a whole, these recommendations represent a departure from traditional assumptions about the nature of water resources and services that have informed regulatory policy in the U.S. up to now.

THREE KEY PRINCIPLES evolved during the Dialogue on Sustainable Water Infrastructure in the U.S. **The first principle is that the traditional definition of water infrastructure must evolve to embrace a broader, more holistic definition of sustainable water infrastructure that includes both traditional man-made water and wastewater infrastructure and natural watershed systems.** While the traditional definition of water infrastructure focused mainly on physical structures associated with drinking water supply and distribution and disposal of wastewater and stormwater, a sustainable water infrastructure integrates these traditional components with the protection and restoration of natural systems, conservation and efficiency, reuse and reclamation, and the active incorporation of new decentralized technologies, green infrastructure and low impact development to ensure the reliability and resilience of our water resources. This new definition of sustainable water infrastructure is necessary to ensure that federal, state and local policies reflect and leverage the interplay between built and natural water infrastructure to achieve clean water. Convergence around this concept of a 21st century definition of a sustainable water infrastructure informed the direction of the dialogue's subsequent policy recommendations.

The second key principle is that this definition of sustainable water infrastructure should be embraced by all public and private entities involved in water management, and these same entities have a shared role in ensuring their decisions consider and integrate a set of criteria that include environmental, economic and social considerations (the Sustainable Path). While this shared leadership role holds the principles of the Sustainable Path in common, the obligations and funding responsibilities of the roles are distinct. Water utilities should take the primary responsibility for setting the full cost price for water service to not only include a sufficient level of expenditure to replace pipes and other capital assets for reliable service, but to fund remediation and/or (ideally) avoidance of any associated adverse hydrological or environmental impacts on the natural watershed system. At the national level, the federal government role is to complement local funding with a focus on particular policy objectives. Such objectives include investment in research, development and demonstration projects; providing financial support in the form of loan guarantees, subsidized loans, granting of tax exempt status to local water debt, ensuring minimum standards and service irrespective of ability to pay; oversight and enforcement of health and safety standards; and investment or assistance with watershed or regional level integration of water

planning and management where appropriate. The federal government can provide both incentives and disincentives for the way that water, wastewater and stormwater utilities contribute to national goals for clean and safe water and how these goals interact with equally pressing national priorities such as energy efficiency, and adaptation to climate change.

Finally, the third principle developed by the dialogue participants is that a watershed-based management approach is required for drinking water, wastewater and stormwater services to ensure integrated, sustainable management of water resources. The full realization of this watershed-based approach necessitates legislative and regulatory reform to remove barriers and create incentives. Water utilities can lead the way by developing policies and practices that promote the preservation and restoration of water resources and by fostering strategic partnerships to collaboratively use integrated water resource planning and management as a tool to examine assumptions concerning supply, demand and alternative methods of meeting unmet future demand and social, economic and environmental challenges.

A SET OF 20 ELEMENTS has been developed that will support a financially and environmentally Sustainable Path to achieve a sustainable 21st century water infrastructure. The Sustainable Path elements include key concepts for good governance, watershed optimization, public outreach, water conservation and energy management, and utility pricing. An appendix to our report lays out the anticipated roadblocks to each of the twenty elements of a Sustainable Path for water infrastructure and offers policy strategies for clearing the way forward.

The following report offers important recommendations for the future of a sustainable water infrastructure in the U.S., based on the intense deliberations of a dedicated group of dialogue participants. While the challenges are great, so too are the opportunities. A new holistic way of thinking about water infrastructure, drawing from the practical lessons learned during the last half century, can lead to a truly sustainable water infrastructure that provides essential clean water services to a growing population, while protecting and restoring the natural watersheds on which so much depends.

INTRODUCTION

Clean water is a precious natural resource that is essential to the health and well-being of our ecosystems, people and economy. Consequently, we have built a complex water infrastructure to deliver potable water to homes and businesses, to carry away, treat and manage wastewater and stormwater, and to store water for future use. Alongside this water infrastructure has evolved an equally complex regulatory framework designed to monitor and ensure water quality. We have also established various financial mechanisms for the construction, maintenance, and development of our man-made (built) water infrastructure.

Yet the task of providing an adequate supply of clean water and sufficient wastewater and stormwater treatment capacity in the U.S. is more challenging now than ever before. Some of the country's water, wastewater and stormwater systems were constructed over 100 years ago. Most were built during the last 50 years with the spread of suburbanization, largely unrestrained by concerns for sustainability. Many of these facilities are at the end of their useful life and need to be either renewed or replaced. Meanwhile, changes in federal clean water and drinking water programs require upgrades in plants, technology and practices that require various forms of investment. In addition, periods of economic distress, taxpayer or ratepayer revolt, rapid increases or decreases in service population, and instability in municipal bond markets have left many communities struggling to fund the maintenance and replacement of their water infrastructure.

Additionally, despite a generation of progress under our Clean Water Act and our Safe Drinking Water Act that Americans can be truly proud of, serious problems still exist for our freshwater resources. Overuse (Americans are profligate with water), poor land-use planning, non-point sources of pollution such as agricultural runoff, and water inefficiency and waste, has impacted the overall condition of our nation's water. Among the different types of ecosystems on earth – freshwater, marine, and terrestrial – some experts believe our freshwater ecosystems are the most vulnerable. According to water supply managers, as many as 36 states may experience water shortages in the next five years, even in the absence of drought. Greatly adding to these challenges are the far-reaching impacts of climate change, which, through changing precipitation patterns, more intense storms, and warmer temperatures that increase snowpack melt and add to droughts, pose a number of new and uncertain challenges for our water supply and management.

To address these serious challenges, it is necessary to approach the problem with a clear understanding of the interdependence of the natural environment that produces clean water with the built infrastructure that manages, delivers and treats water.

The 21st Century Definition of Sustainable Water Infrastructure

The traditional 19th and 20th century definition of water infrastructure focused mainly on physical structures associated with drinking water supply and distribution, and collection and disposal of wastewater and stormwater. The participants of the Aspen Dialogue suggest that this definition, which stops at a pipe's end, is too narrow. **The 21st century definition of sustainable water infrastructure includes the**

A new framework, the Sustainable Path, defines the ideal situation in which all the financial and natural resource costs of providing safe and reliable water services are transparent and costs are managed optimally to produce the greatest benefits.

traditional man-made or built infrastructure components and the natural infrastructure, such as rivers, lakes, streams, groundwater aquifers, floodplains, floodways, wetlands, and the watersheds that serve or are affected by water and wastewater systems. A sustainable water infrastructure integrates the traditional components with the protection and restoration of natural systems, conservation and efficiency, reuse and reclamation, and the active incorporation of new decentral-

ized technologies, green infrastructure and low impact development to ensure the long-term reliability and resilience of our water resources. Sound practice will result in enhancing the triple bottom line of economic, social and environmental sustainability.

Adopting the 21st century definition of sustainable water infrastructure will require a number of adjustments in the way we approach planning, managing and funding water, wastewater and stormwater systems in the U.S. First, it is necessary to reframe the current understanding of the water infrastructure funding gap away from a crisis-driven approach that is not consistent with the goal of long-term sustainability. Rather, a holistic approach that aligns resources with the elements included in a sustainable water infrastructure is needed. A new framework, the Sustainable Path, defines the ideal situation in which all the financial and natural resource costs of providing safe and reliable water services are transparent and costs are managed optimally to produce the greatest benefits. Finally, the leadership necessary to promote the adoption of sustainable water infrastructure in the U.S. will be a shared role between federal, state and local governments, public and private utilities, private investment firms, and citizen groups responsible for assuring the sustainability of water infrastructure for this nation.

THE SUSTAINABLE PATH

Reframing the Water Infrastructure Investment Gap

Water and wastewater infrastructure replacement needs in the U.S. were documented in a 2002 report by the Environmental Protection Agency (EPA) entitled, “The Clean Water and Drinking Water Infrastructure Gap Analysis,” often referred to as the “gap analysis.” The EPA analysis presented a fairly narrow review of replacement investment needs for what is considered traditional water and wastewater infrastructure, such as drinking water pipelines, sewer collection systems, and treatment facilities. It failed, for example, to consider broader water resource needs, including addressing the effects of urbanization on waterways. The gap analysis is a useful, but limited construct for understanding the scope of the infrastructure problem. Our conclusion is that the expanded definition of sustainable water infrastructure noted above will help ensure that water utility asset investment and cost recovery decisions are consistent with the goal of long-term sustainability.

The executive summary of EPA’s gap analysis describes the findings, as follows:

“To gain a better understanding of the future challenges facing the clean water and drinking water industries, the U.S. Environmental Protection Agency has conducted a study to identify whether there is a quantifiable gap between projected clean water and drinking water investment needs over the period from 2000 to 2019 and current levels of spending. The analysis found that a significant gap could develop if the nation’s clean water and drinking water systems maintain current spending and operations practices. However, this gap largely disappears if (*on average*) municipalities increase clean water and drinking water spending at a real rate of growth of three percent per year.”

The EPA gap analysis was subjected to an audit by the Congressional Budget Office (CBO). The executive summary of their report to Congress indicates that while the projections of future costs associated with drinking water and wastewater infrastructure are highly uncertain, the differences between EPA’s and CBO’s projections of future investment costs are not especially significant. Specifically, low-end estimates reflect less than a 15 percent increase and high-end estimates reflect a near doubling in baseline investment costs. However, it is important to reiterate that the EPA gap

analysis, and subsequent analyses building on the original report, focused on a comparatively narrow range of infrastructure needs, primarily pipelines, sewer systems and treatment facilities.

Rather than looking ahead with apprehension, a new framework that looks ahead with intention, by reframing the issue from one focused solely on an “infrastructure gap” towards a more sustainable model or approach to funding water and wastewater infrastructure, is needed.

In the period since the gap report first appeared, its findings have been central to the infrastructure funding debate. Despite the emphasis of the report on uncertainty and the prospective nature of the infrastructure investment gap, the debate has led to perceptions that a crisis already exists.¹ **We submit that a crisis-driven approach, based on the “investment-gap” analysis, will be insufficient to meet the growing challenges facing the nation’s water infrastructure. Rather than looking ahead with apprehension,**

a new framework that looks ahead with intention, by reframing the issue from one focused solely on an “infrastructure gap” towards a more sustainable model or approach to funding water and wastewater infrastructure, is needed.

The Sustainable Path for the Nation’s Water Infrastructure

Following from the expanded definition of the 21st century sustainable water infrastructure, Aspen Dialogue participants articulated a sustainable path forward that can guide water management and funding at all scales. The Sustainable Path defines the ideal situation in which all the financial and natural resource costs of providing safe and reliable water services are plain for all to see and all these costs are managed optimally to produce the greatest benefits. The Sustainable Path follows principles that an urban utility or stormwater agency should be striving to achieve in each of the twenty areas deemed critical to financial and environmental sustainability (Table 1).

This ideal model can be used as a benchmark of comparison by utility management staff, by members of governing boards, by stakeholders of all stripes, by customers and the public at large to compare

1 The Aspen Dialogue participants found the pervasive “crumbling infrastructure” framing of the issue to be potentially misleading or incomplete, especially in terms of the “investment-gap analysis.”

current practices with sustainable practices. Comparison of local conditions against this ideal model may reveal obstacles within the sustainable path that merit policy consideration at local, state or federal levels, and may even provide a more productive focus for public discourse and media attention. A critical examination of where the obstacles lie is also of use in drawing conclusions for national policy and industry standards to promote sustainable water infrastructure (See Appendix 1).

Integrated water resource planning is a useful tool to examine assumptions concerning supply, demand, and alternative methods of meeting otherwise unmet future demand. In this context, utilities should examine how best to use, convey, treat, store, and reuse water efficiently at all scales. And, the regulatory process should enable the implementation of integrated water resource planning at the appropriate scales. Construction and management of the man-made element must consider and accommodate the short and long-term health of the associated natural infrastructure.

“Water management entities” – which include water and wastewater utilities, stormwater management agencies, county health departments, water management districts, state and interstate regulatory entities, and others – must recognize that their mission is shifting toward the Sustainable Path. These entities must take a more thoughtful approach in order to make the built and natural systems function in a more holistic and integrated fashion, to achieve the goal of a sustainable water infrastructure for the 21st century. The future infrastructure must work reliably and on demand and will require the proper level of funding necessary to achieve the mission. A vital key to success along the way is recognizing when to shift investment from the old approach to new, innovative methods that achieve a higher level of sustainable service.

THE SUSTAINABLE PATH ELEMENTS

TABLE 1

<p>Transparency – The sources and uses of funds deployed by water and wastewater utilities and stormwater agencies should be regularly reported in sufficient and consistent detail.</p>	<p>Public Outreach & Stakeholder Involvement – Public, customer and stakeholder involvement in defining sustainable water infrastructure services, and associated funding strategies, should be highly developed and continuous. The public should also be involved in ensuring that sustainability objectives are achieved.</p>
<p>Good Governance – Governing boards, city councils, and utility special district boards with oversight of water and wastewater utilities and stormwater agencies should have the authority – and accept the responsibility – to expand their focus beyond cost control to encompass concerns for sustainability.</p>	<p>Full Cost Pricing – The price of sustainable water, wastewater, and stormwater services should fairly impose the total cost of meeting the requirements of sustainability on ratepayers/customers.</p>
<p>Costs of Development – New development should be charged the full capital, operating and replacement costs of water, wastewater and stormwater capacity through connection or other impact fees. New development and re-development should employ low-impact development (LID) techniques, conservation and reuse strategies.</p>	<p>Asset Management – Best practices in asset management should be applied to identify the best lifecycle cost combinations of repair/rehabilitation/ replacement expenditures. New rehabilitation and replacement technologies, and innovative management approaches, should be used to produce even greater cost savings and better resource management.</p>
<p>Security & Emergency Preparedness – Economic security and preparedness measures appropriate to water and wastewater utilities and stormwater agencies should be deployed to assure overall system reliability and resiliency.</p>	<p>Conservation & Water Efficiency – Utilities should encourage water-use conservation and efficiency to reduce long-term system costs and produce additional societal benefits.</p>
<p>Stewardship – Utilities and stormwater agencies should adopt a leadership role in promoting sustainability of the natural infrastructure of rivers, lakes, streams, groundwater aquifers, floodplains, floodways, wetlands, forests, and watersheds.</p>	<p>Energy Management – Utilities and stormwater agencies should maintain adaptive strategies to deal with increasingly complex choices presented by the need to minimize energy use and greenhouse gas emissions while ensuring system reliability and striving for continual improvement in water resource management.</p>

<p>Climate Change Mitigation & Adaptation – As water and wastewater utilities and stormwater agencies build and re-build their infrastructure, they should consider what type of infrastructure is right for the future, balancing needs for system reliability, needs for mitigation of embedded carbon and green house gas emissions, as well as needs for adaptation to climate change in areas such as water resource management, source water protection and stormwater management</p>	<p>Advanced Procurement & Project Delivery Methods – Utilities should strive to attain cost advantages through alternative forms of procurement for such things as bulk chemicals. Design/Build and Design/Build/Operate approaches to construction project delivery and other forms of public/private partnerships should be considered as alternative strategies to deliver major capital projects when they may offer cost advantages.</p>
<p>Modernized Plant Operations – Utilities should employ modern management practices to strive for continually improved treatment plant operations.</p>	<p>Environmental Impacts – Water and wastewater utilities should evaluate and implement alternative approaches that minimize the adverse hydrological and environmental impacts of their operations.</p>
<p>Watershed & Regional Optimization – Water and wastewater utilities and stormwater agencies should engage in collaboration and partnerships to maximize positive environmental and public health outcomes at watershed and regional scales.</p>	<p>Network Optimization – As water and wastewater utilities and stormwater agencies build and re-build infrastructure, they should strive to work in close collaboration with each other and with state and municipal road and highway agencies to obtain significant cost savings and environmental benefits.</p>
<p>Regulatory Optimization – Utilities and stormwater management agencies should work with regulators, stakeholders and each other to pursue significant potential cost savings and additional benefits that could be derived from closer integration of regulatory program implementation and innovative compliance strategies.</p>	<p>Workforce Management – A highly capable, flexible workforce armed with modern information technology, and modern labor relations approaches, are necessary to attain and sustain optimal performance.</p>
<p>Affordability – Water and wastewater utilities and stormwater agencies should provide service at the most efficient cost, while also employing a wide selection of best practices to assist low-income customers.</p>	<p>Research and Technological, Managerial Innovation – Utilities should invest in research and innovation particularly focused in technology and management improvements with the outcome of improving efficiency, quality of service, and environmental protection and restoration.</p>

The Sustainable Path for Small Systems

The above discussion has focused mostly on larger urban settings. Small communities and small systems face different challenges that require separate attention in devising infrastructure policy. Of the approximately 53,000 community water suppliers, 45,000 are small systems (i.e., serving fewer than 1,000 customer connections). Half of these small systems are privately owned, serving fewer than 100 connections and operated by part-time employees. Of the 17,000 wastewater treatment plants in the U.S., at least 15,000 have capacities of less than 1 million gallons per day, serving populations of less than 10,000.

In addition to extreme differences in the types of organizations involved, there are also great differences in the nature of infrastructure issues involved. About half of all small systems are small rural communities and about half are small suburban communities built by developers to serve small clusters of homes. Small systems were often built over one or a few short periods of time when the area experienced an economic boom phase, and replacement needs may therefore be more temporally concentrated. Often, unexpected adversities (e.g., well contamination, loss of a large customer, etc.) pose the greatest threats to sustainability of small systems due to their limited ability to absorb large financial shocks. Access to capital is an issue for many of these small systems.

Many small systems have limited capacity to plan ahead and take advantage of available options. Most are concerned with day-to-day operations and short-term survival rather than long-term sustainability. Planning and financial assistance will likely be required in order to map out the sustainable path for smaller water service providers.

Federal loan programs such as the EPA State Revolving Fund programs, the USDA Rural Development Administration loan program and the Community Development Block Grant program have evolved mechanisms to provide assistance to such systems, and enhancement of these existing mechanisms is a likely first place to look for strategic direction.

Another long-standing solution that has been proposed for small systems is consolidation, or regionalization. By combining forces at a larger scale, small communities can take advantage of

economies of scale in both technical and financial matters and achieve more resilient and sustainable operations. Consolidation can be accomplished by physical interconnection among adjacent systems. Wholesale water purchase agreements with larger water systems and regionalized wastewater treatment plants in many metropolitan areas are the most prevalent arrangement.

Other types of “soft” approaches to the particular challenges faced by small systems involve institutional reforms to create special districts or authorities that provide centralized financial, managerial and technical services to decentralized physical systems with varying degrees of independence, depending upon the arrangements.

By combining forces at a larger scale, small communities can take advantage of economies of scale in both technical and financial matters and achieve more resilient and sustainable operations.

Finally, acquisition and absorption of small systems has been undertaken in many instances by larger utilities – both publicly owned and investor owned – with and without physical interconnection. Finding the most sustainable path for small systems is inherently a local matter that depends heavily on local conditions and preferences for governance.

SHARED LEADERSHIP ROLES FOR THE SUSTAINABLE PATH

Common Goals and Creative Policies

Participants in the Aspen Dialogue agreed that a sustainable water infrastructure will require a cooperative strategy among all the key stakeholders and regulators, including water, wastewater and stormwater service providers, as well as local, state and federal agencies. This means the adoption of financial and management policies that reflect a sense of shared responsibility between all relevant organizations, all directed toward the mutual goals of protecting the resiliency of natural watersheds and ensuring dependable water services for every community, large and small.

How this cooperation and sharing of responsibility between private industry and public agencies takes form will vary to some extent, based on the needs of specific communities and the condition of the built infrastructures and natural watersheds where they reside. An effective governance regime will allow for sufficient flexibility and cooperation between water

A sustainable water infrastructure will require a cooperative strategy among all the key stakeholders and regulators, including water, wastewater and stormwater service providers, as well as local, state and federal agencies.

service providers and regulators at all levels, as they work together to develop solutions that adhere to the elements of the Sustainable Path described in this report. To that end, an ideal water infrastructure governance model is one which:

- Focuses on achieving specified public and ecosystem health outcomes
- Balances local, regional, and global outcomes over various timeframes
- Appropriately addresses all sources that impact ecosystem and public health
- Fairly allocates responsibility and costs
- Achieves its mission at the lowest total cost to society, and is adequately funded

Many obstacles to funding and managing a sustainable water infrastructure can be overcome in time with committed utility management, public support and political will. Intervention to

address such obstacles might be considered at federal, state or local levels, and could involve financial resources as well as an array of other measures, such as government-sponsored research, regulatory incentives, or enforcement. However, in keeping with the concept of sustainability, the long-term objective should be to minimize obstacles to the Sustainable Path by creating incentives that induce the behavioral changes needed.

Whereas water and wastewater utilities and stormwater agencies cannot control all the factors within their watershed or region that affect their costs or their ability to affect environmental outcomes, they should collaborate with other organizations to maximize environmental and public health at watershed and regional scales. Integration, collaboration, coordination and/or consolidation of utilities on a watershed basis has been found to be effective strategies in protecting and restoring surface and groundwater resources.

As water and wastewater utilities and stormwater agencies build and re-build infrastructure, they should strive to work in close collaboration with each other and with state and municipal road and highway agencies in order to obtain significant cost savings and environmental benefits, such as those produced through adoption of green infrastructure for stormwater management.

Utilities and stormwater management agencies should work with regulators, stakeholders and each other to pursue significant potential cost savings, improved water quality, and other environmental and public health benefits that could be derived from closer integration of regulatory programs. These programs could include innovative compliance strategies linking stormwater management programs, wet weather programs (Combined Sewer Overflows and Sanitary Sewer Overflows), source water protection programs, and water supply needs through such mechanisms as integrated water resource management, watershed-based permitting, stormwater harvesting, graywater reuse, and other approaches. The net result would be superior outcomes at reduced cost.

Water and wastewater utilities should be evaluating and implementing alternative approaches that minimize the adverse hydrological and environmental impacts of their operations. This is accomplished by adopting approaches that go beyond simple compliance with regulatory requirements and reduce the environmental impacts of their activities and, ideally, result in environmental enhancement.

Economic, social, and environmental sustainability for water, wastewater and stormwater projects cannot be achieved overnight. If the principles embodied by the Sustainable Path are followed, regulators could extend permit and consent decree timelines to accommodate the greater difficulty that may be involved in reaching a sustainable result.

THE CHALLENGE OF AFFORDABILITY

Affordability issues are particularly acute in communities with high proportions of low-income customers and extraordinary water infrastructure investment needs. Historically, some federal funding programs have directed subsidies to large-scale projects or entire utility systems with the intent that some of the benefits will help address affordability. While relatively simple to administer, this approach can subsidize customers that do not need it. Other federal programs, most notably, HUD's Low Income Heating and Energy Assistance Program (LIHEAP), directly help low-income customers pay their bills to energy utilities and heating fuel suppliers through established local social service agencies. This latter form of subsidy is somewhat more complex to administer, but tends to focus federal assistance on those individuals that need it the most.

Equitable distribution of environmental, public health and safety outcomes is the key rationale for directing federal and/or state funding to help keep essential water services affordable. For smaller and impoverished communities, system-level subsidies may be necessary, effective, and reasonably efficient. In many other instances, direct assistance may be a more effective and efficient way to target subsidies to low-income and payment-troubled households. A LIHEAP-like mechanism has the added benefit of engaging state and local social service agencies to allocate subsidies to households, providing invaluable assistance to utilities in this task that lies outside their core mission.

Proposals have been made for a water infrastructure version of the LIHEAP program, possibly as a supplement or piggy-back to the energy program. A possible pitfall of such proposals is the reliance on annual Congressional appropriations. Further, estimates are that LIHEAP benefits reach only 20 percent of eligible households. Despite the reality that federal resources may never be fully adequate, the flow of dollars through the LIHEAP program may provide a useful means of reforming water utility assistance initiatives by effectively focusing attention on households in need, leveraging experienced social-service agencies, and mobilizing additional state and local resources where possible.

Finally, neither community-level nor household-level federal subsidies should be viewed as a panacea for resolving affordability issues. They should not supplant local assistance efforts or diminish national commitments to cost-effective environmental regulations, cost-effective utility operations, and access to essential services in a rising cost environment.

Since water, wastewater and stormwater infrastructure includes the rivers, lakes, wetlands and watersheds that serve or are affected by the water and wastewater system, it follows that maintenance of this natural infrastructure is equally important. This necessity should be reflected in regulatory agency action concerning permits and conditions for water, wastewater and stormwater facilities. Congress, for example, could encourage integrated water resource management, sustainability principles, best management practices, and watershed protection measures, in order to protect source waters and riparian corridors.

Finally, to achieve the positive outcomes suggested by the Sustainable Path, the regulatory process must be adequately funded. While the federal government establishes minimum standards and uniform procedures that must be adopted by all states, most regulatory actions that impact watersheds are actually accomplished at the state or local level. These state and local agencies need the necessary authorities, political and popular support, *and* funding to assist local interests in achieving sustainable outcomes.

Federal Funding and the Sustainable Path

Providing safe drinking water and assuring that both community wastewater and stormwater are managed in ways that protect our nation's water resources require billions of dollars each year for both operating and capital expenditures. Under-investing, or targeting investments in these

The federal assistance role can and should be used to further the sustainability of water infrastructure over time, consistent with related goals of public health, environmental protection, and economic development.

critical resources unwisely, has serious social consequences in the present and in the future. A key public policy question is what is the most appropriate federal funding role with regard to sustainable water and wastewater infrastructure utilities?

Participants in the Aspen Dialogue agreed that the federal assistance role can and should be used to further the sustainability of water infrastructure over time, consistent with related goals of public health, environmental protection, and economic development. Whatever the specific funding mechanism, a focus on particular policy objectives, such as investment in research, development and demonstration projects; financial support in the form of loan guarantees; subsidized loans; granting of tax exempt status to local water debt; establishment and enforcement of minimum standards and service irrespective of ability to pay; oversight and enforcement of health and safety standards; and assistance with watershed or regional level integration of water plan-

ning and management where appropriate are all necessary and important contributions. At this juncture, Dialogue participants did not agree on the merit of a federal trust fund for water infrastructure and this report does not contemplate (or prejudice) the investment utility or political actuality of such a fund.

The federal government can provide both incentives and disincentives for the way that water, wastewater and stormwater utilities contribute to national goals for clean and safe water and how these goals interact with equally pressing national priorities such as energy efficiency, green infrastructure, environmental sustainability, and adaptation to climate change. While the majority of water and wastewater infrastructure services currently are funded by local

sources, the strategic use of federal assistance can still have a major impact promoting sustainable infrastructure. Where local solutions are impractical or improbable, the federal government has a role in protecting the environmental commons to prevent environmental degradation and protect public health. Part of that role might be support of watershed-based management approaches that facilitate regional decision-making, and part might be in helping to offset the costs of effective and efficient regional water management solutions.

While in absolute terms, federal funding now plays a modest role in funding water infrastructure in the U.S., for some communities federal funding can be important enough to influence system behavior either positively or negatively. Part of understanding this dynamic requires examining the historic role of the federal government in financing public water systems.

Many historical infrastructure financing mechanisms have not evolved despite increasing awareness and understanding of changing cost and water usage profiles, watershed management, the water-energy nexus, global climate change, and affordability challenges. Likewise, many existing financing practices, policies, and institutions are not well suited to support the full range of infrastructure and programs needed for sustainable water and wastewater utilities in the 21st century. For example, traditional financing might favor traditional supply-side options (such as new treatment plants), rather than investments in more cost-effective asset management or efficiency technologies.

The federal government can provide both incentives and disincentives for the way that water, wastewater and stormwater utilities contribute to national goals for clean and safe water and how these goals interact with equally pressing national priorities such as energy efficiency, green infrastructure, environmental sustainability, and adaptation to climate change.

More attention to the incentives and disincentives of federal funding are needed, particularly with respect to encouraging or discouraging sustainability. Without proper safeguards, grant programs or subsidies designed to relax the financial pressures of addressing environmental degradation or public health threats in targeted communities may promote less efficient levels of infrastructure investment and less efficient maintenance of infrastructure assets. Similarly, subsidies through needs-based grant programs can be helpful, but in some cases may have unintended consequences. For example, grants or low-cost loans to sewer a community with failing septic tanks could lead to unanticipated growth that ultimately degrades local water quality and creates equal or greater environmental costs.

Federal funding might be used to enhance local revenue-raising capacity through matching provisions. One example is the need to increase local rates for service; necessary increases might be more politically palatable to citizens and local officials if failure to raise additional revenues would result in a loss of federal funding. Federal funding can also be tied to performance goals based on sustainability criteria, as well as to cost accounting and rate reform. A critical caveat is that making federal funding available to some systems and not others raises issues of equity, as well as incentives. Funding that offsets the cost of service mutes price signals to water customers, which undermines long-term resource efficiency and local sustainability. For this reason, it is crucial that the use of federal funding be checked against the principles of the Sustainable Path to ensure the goals of long-term environmental, social and economic sustainability.

Finally, federal infrastructure funding agencies should use their authority and resources to support infrastructure investments that are especially difficult to fund through local sources due to unusually high costs relative to local incomes, or that have the potential to mitigate negative or enhance positive environmental impacts extending beyond local water system service territories. These high-priority investment opportunities include multijurisdictional watershed protection and restoration projects; large-scale wet weather infrastructure; non-point source pollution control; innovative and integrative water management models; conservation programs targeted to customers in need; advanced technologies for green infrastructure, water and energy efficiency, and global climate change response; and research and development and demonstration projects. The strategic use of federal funding in meeting 21st century priorities will move water systems along the Sustainable Path, while ensuring equitable access to safe water for all citizens and adequate protection of the natural environment, now and into the future.

CONCLUSION & POLICY RECOMMENDATIONS

Throughout much of the Aspen Dialogue there was an important assumption shared by many, but not all, that the new integrated and holistic management of water infrastructure would be heavily reliant on water, stormwater and wastewater utilities as the central planners, coordinators and implementers of a new and improved method. Though this is the case among many of the larger water utilities that have moved forward in a more integrated and holistic fashion, not all utilities are ready to play this role.

What is clear is that there will likely be multiple arrangements, especially during a transition period. The question of how the water utilities relate to and coordinate with strategic partners in carrying out the broad scope of work identified in the new Sustainable Path approach is an important one to evaluate further. In most cases, there likely will be some admixture of water utility, governmental, private market and non-governmental entities that will work together to fulfill the mission.

Which jobs go to what sector, where funding comes from to pay for the different components of any plan, how much of the system is centrally built, maintained and operated, versus a decentralized and distributive approach, are key questions. The governance principles for this wide set of variables are not fully worked out, nor are the statutory, regulatory and market mechanisms that are needed. Nevertheless, by virtue of current political and economic urgencies, decisions that impact the country's future water infrastructure are rapidly being made, as "shovel-ready" projects are set in motion.

By embracing the new roles and responsibilities articulated in the Sustainable Path, water utilities, supported by governments, public and private entities, can lead the way in seeing that the environmental degradation of our nation's water resources is halted and in fact changes direction. They can lead the way in ensuring that all Americans have equal access to water, while also getting Americans to understand the true value of the resource through good governance, pricing, and educational efforts. And they can lead the way in keeping our community, regional, and national economies strong by seeing that water, wastewater, and stormwater services can be relied on for future decades.

Recommendations:

- 1. The water management and policy community must redefine “water infrastructure” as one that integrates built infrastructure components with the protection and restoration of its supporting natural watershed infrastructure and the use of emerging small-scale water technologies and water management solutions.**

The traditional nineteenth and twentieth century definition of water infrastructure focused mainly on physical structures associated with drinking water supply and distribution and collection and disposal of wastewater and stormwater. However, the sustainable functioning of these systems is dependent on the natural systems to which they are inextricably linked, including lakes, streams, rivers and riparian areas, groundwater aquifers, forests and wetlands. Also necessary in a new definition of water infrastructure is the inclusion of emerging small-scale embedded technologies that contribute to water efficiency, re-use and conservation. Such technologies include, but are not limited to, decentralized (e.g. in-house or neighborhood-scale) sewage treatment systems and gray-water recycling, porous pavement, cisterns, vegetated roofs, bio-swales and rain gardens.

- 2. Watershed-oriented entities, at scales and compositions appropriate to local conditions, should manage the redefined water infrastructure according to the principles of the Sustainable Path. These entities should foster collaboration, cooperation and integration between utilities and agencies to provide water, wastewater and stormwater services, achieve sustainable management of surface and groundwater resources, and ensure environmental protection and enhancement.**

Water and wastewater utilities and stormwater agencies should engage in collaboration with others to try to maximize positive environmental and public health outcomes at watershed and regional scales. Integration, collaboration, coordination, or consolidation of utilities on a watershed basis has proven effective in integrating management and protection/restoration of surface and groundwater resources.

- 3. Federal, state and local officials should adopt watershed-oriented policies and regulations that incorporate the principles of the Sustainable Path into funding decisions.**

Resource management entities and water utilities should adopt the Sustainable Path principles in their operations and administration.

A complex regulatory framework has evolved over the past half-century that is generally designed to prohibit contaminants from potable and non-potable treated water, rather than on the broader concepts of ecological health or sustainability. In keeping with the concept of sustainability, regulations should create incentives for behavioral changes that are more synchronous with the Sustainable Path.

- 4. Water utilities must lead in building partnerships that will use integrated water resource planning and management as a principle tool for preserving and restoring water resources while meeting human and ecosystem needs for water in the context of a changing climate.**

Water utilities and other entities such as energy suppliers, transportation agencies, commercial developers, local governments, industries and non-governmental organizations should work together to examine assumptions concerning water supply and demand and devise alternative methods of meeting otherwise unmet future demand and other social, economic and environmental challenges. Water management entities should actively adopt strategies to deal with increasingly complex choices to minimize energy use and greenhouse gas emissions, while also ensuring system reliability and resilience and striving for continual improvement in water resources management goals.

- 5. Federal, state and local governments and other entities should find ways to remove or modify institutional barriers and practices that impede or prevent sustainable water resource management according to the principles of the Sustainable Path, and should actively address all sources of pollution, degradation and depletion on a watershed basis.**

Governing agencies at all levels should cooperate in pursuing cost savings and additional water quality and other environmental and public health benefits that could be derived from closer integration of regulatory programs. Such programs could include innovative compliance strategies linking stormwater management programs, wet weather programs (Combined Sewer Overflows and Sanitary Sewer Overflows), source water protection pro-

grams, and water supply needs through such mechanisms as integrated water resource management, watershed-based permitting, stormwater harvesting, graywater reuse, and other approaches.

- 6. Utility and system managers as well as regulators and governing boards should ensure that the price of water services fairly charges ratepayers or customers the total cost of meeting service and sustainable water infrastructure requirements, subject to concerns about affordability. Funding for water utilities should generally rely on cost-based rates and charges, and these revenues should not be diverted to unrelated purposes.**

Full-cost pricing is a sound business practice that is helpful in obtaining debt financing. The resulting price signal to consumers is also good practice from the perspective of promoting wise water use. Where it is necessary to undertake actions to avoid, mitigate and compensate for environmental impacts, these additional out-of-pocket costs should be considered in the full cost of providing service.

- 7. Water utilities should employ a variety of practices on the path to sustainability, including: transparency in governance and operation; public outreach and consultation; integrated water management; asset management; workforce management; conservation and efficiency (both water and energy); advanced procurement and project delivery methods; adaptation to and mitigation of climate change; research and development; and technological and managerial innovation.**

Water management entities must take a more thoughtful approach in order to make the built and natural systems function in a more holistic and integrated fashion, to achieve the goal of a sustainable water infrastructure for the 21st century. This new approach must ensure that the infrastructure works reliably and on demand, and that there be the proper level of funding necessary to achieve the mission. Water infrastructure decisions must consider, value and integrate a triple bottom line set of criteria that include environmental, economic and social considerations.

- 8. Federal and state agencies, and water utilities provide assistance to water service systems – especially small systems – to improve their financial, managerial, technical and planning capacity to implement all the elements of the Sustainable Path.**

Small communities and small systems face different challenges that require separate attention in devising infrastructure policy. Infrastructure replacement issues are tightly intertwined with the full range of small system capacity development and sustainability issues that have been the substance of policy discussions in this area for decades. Enhancement of existing federal loan programs is a likely first place to look for strategic direction. Another is consolidation or regionalization of small systems, which could take advantage of economies of scale in both technical and financial matters and achieve more resilient and sustainable operations.

- 9. The federal government shares the responsibility for achieving the Sustainable Path. Therefore, federal funding should target investments in 21st century priorities, including “green infrastructure;” water and energy efficiency; climate change adaptation; support for clean and safe water for economically distressed households; research, development and demonstration projects for integrated water management; and incentives for sustainable utilities.**

Water, wastewater, and stormwater infrastructure provide fundamental health, environmental, and safety underpinnings to the entire domestic economy. Large, regional water systems generate benefits that sometimes take a long time to flow, and adoption of innovative technologies and processes can be risky. Because of its unique position, the federal government can spur technological innovation and standards that support clean water and safe drinking water.

- 10. Water utilities should apply appropriate practices to assist low-income customers. Federal and state funding agencies should direct affordability support principally towards households in need, except where community-level assistance is effective and efficient.**

Creating best practice customer payment assistance programs at the utility level is the key to ensure that all customers have access to affordable utility services. A strategic payment assistance program that treats household affordability, rather than community-level affordability, can be effective in achieving full-cost recovery, while minimizing negative effects on fiscal accountability.

APPENDIX I

Obstacles in the Sustainable Path and Suggested Remedies

The following matrix identifies potential obstacles that may lie in the Sustainable Path to water infrastructure funding and suggests remedies to address them.

Pathway Elements	Potential Obstacles	Potential Remedies
1 – Transparency	Variable accounting practices in many municipalities.	Apply daylight and reform errant municipal accounting practices. Large role for local and state government leadership.
2 – Public Outreach & Stakeholder Involvement	Citizen information overload and apathy/interest level; lack of responsiveness of utilities to citizen views.	Apply professional methods to reach audiences; develop media relationships; follow-up on feedback received.
3 – Good Governance	Narrow focus of governing boards, councils and regulatory commissions.	Broaden the charter of governing boards, councils, and regulatory commissions to encompass sustainability goals. Large roles for public outreach/stakeholder involvement and leadership at all levels.
4 – Full Cost Pricing	Historical pricing practices; unwillingness to charge; inertia of the status quo; citizen concern that rate hike does not reflect added value in services/benefits.	Encourage transparency and reform pricing practices focusing on improved cost knowledge and efficiency. Large role for water industry leadership and local and state government leadership.
5 – Costs of Development	Resistance to connection fees, impervious area fees, and stormwater control regulations; potential influence of developers on local officials.	Imposition of connection fees, impervious area fees and stormwater regulations, noting the net benefits to property owners and tax payers. Large role for water industry leadership, local and state government leadership, and business leaders.

Pathway Elements	Potential Obstacles	Potential Remedies
6 – Asset Management	Lagging acceptance/adoption of asset management practices in the U.S. due to perceived complexity and inherent need for cultural shifts from business as usual.	Education and possibly incentives for adoption of asset management practices. Large role for water industry leadership and research; possible role for State & Federal leadership.
7 – Security & Emergency Preparedness	Difficult/expensive decisions involving low probability/high consequence events.	Risk management methods.
8 – Conservation & Water Efficiency	Concerns about revenue erosion associated with rising fixed costs and relatively flat demand.	Rate adjustments; pricing mechanisms that ensure adequate revenue for utility even with declining use.
9 - Stewardship	Jurisdictional authority/legal authority may limit the ability of utilities to proactively engage in certain activities. Political realities may also be a limiting factor.	Promote stewardship initiatives; public education can play a role in changing legal and political constraints.
10 – Energy Management	Rising energy costs and significant energy requirements of water and wastewater utilities.	Sophisticated optimization techniques, encompassing cost, reliability, and other objectives (e.g., GHGs); joint efficiency, water conservation and efficiency, management and cogeneration opportunities. Large role for water industry leadership, research, and partnerships with power providers.
11 – Modernized Plant Operations	Overcoming the inertia of the status quo to promote more efficient operations.	Requires capital investment in technology, management capability, and careful implementation to enhance confidence and build support.
12 – Advanced Procurement & Project Delivery Methods	Acceptance of new methods can take time, especially when the dollar size of the undertaking is large relative to utility operating budgets.	Case histories of both good and bad experiences are valuable to building confidence with new approaches.

Pathway Elements	Potential Obstacles	Potential Remedies
13 – Climate Change Mitigation & Adaptation	Cost of, and resistance to, significant departures from conventional infrastructure solutions (e.g., in developing new sources of supply and in stormwater management).	Triple bottom line analysis; possible need for incentives; large role for public outreach/ stakeholder involvement; need for Federal, State and local government and water industry leadership, R&D, and demonstration projects;
14 – Environmental Impacts	Not all environmental impacts can be handled through market or pricing mechanisms.	Implement alternative regulatory and market approaches to mitigate adverse hydrological and environmental impacts of operations.
15 – Watershed & Regional Optimization	Jurisdictional boundaries and historical rivalries.	Apply effort to positive collaboration and coordination; possible need for incentives; large role for local government and water industry leadership; State & Federal leadership required to optimize the watershed approach
16 – Network Optimization	Resistance to collaboration between water agencies and state and local transportation departments.	Apply effort to positive collaboration and coordination; possible need for incentives; large role for local government leadership; possible role for State & Federal leadership.
17 – Regulatory Optimization	Disconnects between stormwater management programs and wet weather programs (CSOs and SSOs), favoring grey vs. green infrastructure at higher cost and less environmental benefit.	Need for public/stakeholder involvement and significant State and local government and Federal leadership through performance based requirements, flexibility, watershed approaches, and incentives for green infrastructure.
18 – Workforce Management	Lack of appropriate skills and flexible workforce approaches.	Workforce development, leveraged with technology, and modern labor relations; large role for water industry and union leadership.

Pathway Elements	Potential Obstacles	Potential Remedies
19 – Affordability	Increasing costs impose increasing burdens on households facing broader financial problems.	Engage others in the community and vigorously apply best practices in customer payment assistance programs; large role for local government and water industry leadership.
20 – Research and Technological and Managerial Innovation	High hurdle costs of initial R&D in some new areas	Leveraging of utility research efforts through industry research foundations and Federal and state research support.

APPENDIX II

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