Sustainable Water Systems

A Primer for Water Utility Decision Makers

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For more information, please go to www.CommonAssets.org.

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Introduction

Water is the foundation of all life – it quenches our thirst, nourishes our crops, livestock and fish, and carries away our waste. It is an integral component of a nation's standard of living and is essential for creating a sustainable society. Globally, more than one billion people lack access to adequate, safe drinking water and nearly two-and-a-half billion people lack access to improved sanitation. Thousands die every day from water-related diseases, and instances of water-related conflict and violence are reported weekly. Although the United States has near universal access to clean drinking water and sanitation services, it, too, faces challenges in securing and managing its water resources and the infrastructure systems that supply it and keep it clean.

> A nation that fails to plan intelligently for the development and protection of its precious waters will be condemned to wither because of its shortsightedness. The hard lessons of history are clear, written on the deserted sands and ruins of once proud civilizations.
> **President Lyndon B. Johnson**

Because the majority of American water systems are locally controlled, public agencies, the enormous responsibility of protecting our water commons falls into the hands of public utility commissioners and other water policy makers. Yet these officials – many of whom are citizen volunteers – have little access to the training and support they need to protect our common resources and achieve critical system management and operational objectives.

This primer is intended to provide public utility decision makers with a framework for addressing the profound challenges facing community water systems. The first chapter discusses the seven main challenges facing America's community water systems. While no one community has to contend with every one of these challenges at one time, each looms on the horizon and will have to be faced sooner or later. The second chapter provides five basic understandings of water and water systems that must frame any long-term stewardship effort. The third section lays out the five strategic steps to guide commissioners' sustainability and stewardship agenda.

Though the challenges facing our water systems are great, the stewards of our water commons, equipped with the proper resources and training, can ensure that future generations will continue to have access to this vital common asset.

> If surface water can be compared with interest income, and non-renewable groundwater with capital, then much of the West was living mainly on interest income. California was milking interest and capital in about equal proportion. The plains states, however, were devouring capital as a gang of spendthrift heirs might squander a great capitalist's fortune.
>
> **Marc Reisner, *Cadillac Desert***

Seven Challenges for Community Water Systems

Rising Demand

America's growing population is placing greater pressure on domestic water supplies. According to the U.S. Census Bureau, over the next 20 years our nation's population is expected to increase to more than 335 million people, a 13.5 percent increase from today's count of 295 million. Americans use more than 185 gallons of water per person per day – the most in the world. Total water use has stabilized since 1980 (meaning per capita use has steadily declined), however an average of an additional 740 million gallons of water per day, every day, will be needed if personal use simply keeps pace with population growth.

Most water use is not for domestic purposes; human consumption comprises less than 15 percent of the fresh water used in this country. According to the U.S. Geological Survey (USGS),[i] nearly half of our nation's fresh water consumption is for industrial and energy related uses. Agriculture and livestock production takes up almost as much. In some states, all west of the Mississippi, agriculture takes more than 90 percent of the fresh water. Because it is improperly priced, fresh water is often used for low-value, water-intensive crops such as cotton and alfalfa.

Dwindling Supplies

Although our nation is rich in water resources, useable supplies are rapidly shrinking due to pollution, degradation of source watersheds, competing needs and depletion of the easiest-to-obtain sources. The problem is particularly pronounced in the arid Western and Southwestern states, as well as in the Central Plains states. Global climate disruptions will likely make the problems worse as storms become more intense, snow packs melt sooner and warmer temperatures increase evaporation loss from reservoirs.

Public water systems serve more than 250 million Americans. More than 40 million people who are not served by public systems – including nearly all of the rural population – rely on private, domestic wells. About 60 percent of our nation's public water supply comes from surface waters –

both natural, such as lakes and rivers, as well as man-made, like reservoirs. The rest comes from groundwater sources in underground aquifers. Half of the population depends on underground aquifers, and about 30 trillion gallons are pumped yearly in the U.S. For every five gallons we pump out, nature replaces only four. In some places the rate of depletion is much higher. For example, the High Plains Ogallala Aquifer, that stretches 1,300 miles through America's heartland from South Dakota to Texas, is being used eight times faster than its natural recharge rate. Forests that are critical to maintaining watershed health and boosting the water table are disappearing under sprawl and development. Increased impermeability in newly urbanized environments increases runoff into fast flowing streams and rivers rather than allowing water to percolate into the ground to replenish aquifers.

Surface water sources are not faring much better. Withdrawals from rivers and subsequent discharges miles from where the water was taken have reduced in-stream flow causing disruptions in the water balance, worsening water quality, and disrupting wildlife habitat. Furthermore, rivers, streams, and lakes have been so mismanaged by decades of well-intentioned, but ultimately counterproductive, water projects and industrial pollution that their usable water is rapidly declining. For example, Lake Powell in Arizona's high desert, which was created in the 1950s by the damming of the Colorado River in Glen Canyon, loses enough water per year to evaporation and seepage into the canyon walls to supply the entire city of Los Angeles. This is three times Nevada's annual allotment of the Colorado River and enough to supply the Salt Lake Valley for five years.[ii] Lake Mead, behind Hoover Dam and downstream of Lake Powell loses even more water as temperatures in the Nevada desert reach nearly 120 degrees in the summer. If all the water loss of the lakes and rivers of the Colorado River system were applied to Lake Mead, it would be completely empty.[iii] Even the Great Lakes, which contain nearly 20 percent of the world's fresh surface water, are facing an uphill battle against overuse, as well as industrial, agricultural and urban pollution.

National Fresh Water Use in 2000 by Sector

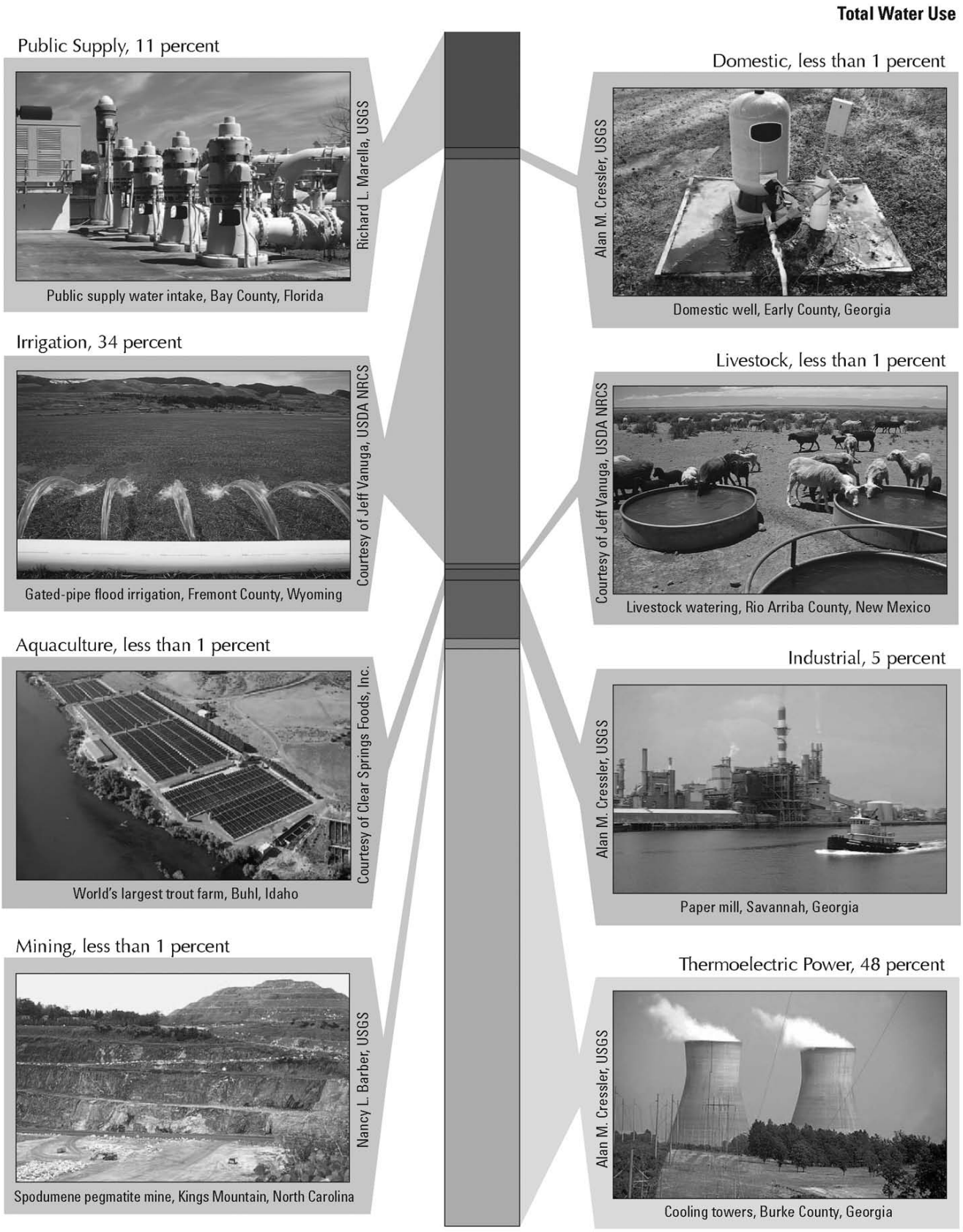


Figure 1. Total water withdrawals by category, 2000.

Source: U.S. Geological Survey, Estimate of Water Use in the United States 2000

Stronger Health and Environmental Standards

In 1972, the Congress passed and the president signed the Clean Water Act, which promised Americans safe water for drinking, swimming and fishing. More than 30 years after the Clean Water Act's passage (and the complementary Safe Drinking Water Act of 1974), our waterways remain threatened and an overwhelming majority of Americans live within 10 miles of a polluted river, lake or coastal water. States report that close to 40 percent of their surveyed waters are too polluted for basic recreational uses. Yet despite the overwhelming unmet needs for clean water, in recent years both state and federal regulators have been reluctant to fully enforce the Clean Water Act's protections.

Although some regulators are reluctant to enforce the promises of the Clean Water Act, its provisions remain in force and new standards ultimately come on-line, such as the Total Maximum Daily Load provisions that control how much of a pollutant can enter a water body. And we are continually learning more about the links between environmental quality, clean water and human health. The Environmental Protection Agency (EPA) is studying the health and environmental effects of dozens of biological and chemical pollutants. As our knowledge of emerging pollutants and their effects on public and environmental health develops further, water quality standards will undoubtedly become stronger.

More importantly, the public continues to overwhelmingly demand strong protections for their drinking water and waterways. National surveys have consistently shown that Americans demand clean drinking water and clean waterways, placing them high on the priorities for public investment and action. Keeping up with advances in our understanding of the need to protect our waters will require both management expertise as well as money.

Emerging Technologies

Growing demand, limited supplies, and tightening water quality standards are driving the need for new technologies in all facets of water utility operations – from drinking water purification to stormwater management to wastewater recycling and solids disposal. Bringing these technologies on-line will require managing their introduction into complex systems, training staff to properly operate them, planning and financing their ongoing maintenance, and fully addressing their environmental impacts.

Coastal communities facing shortages from surface and groundwater sources are increasingly looking to desalination to provide their population with the water they need. Desalination is an expensive, energy-intensive technology that separates salt from seawater in a process called "reverse osmosis." The process discharges a thick, soupy brine that can be toxic to aquatic life. Desalination is also used in inland areas to treat brackish or polluted groundwater supplies, leaving communities with disposal challenges. Costs for this process are, however, widely expected to drop as improved manufacturing methods and economies of scale are realized, thereby increasing the likelihood of its deployment. While the technology comes with its own challenges, strategic use of desalination can help reduce surface water diversions and ameliorate the effects of droughts.

Because growing demand is rapidly exceeding the availability of existing, easy-to-access, fresh water sources, communities are being forced to turn to lower-quality water sources and under-

Emerging Technologies on the Horizon

- ***Marine Corp Base Camp Pendleton, CA - Advanced Potable Treatment for Supply Reliability***

  The U.S. Navy, the Bureau of Reclamation, and the Fallbrook Water Utility District are planning to upgrade their groundwater-recharge and recovery system in order to improve local water self-sufficiency and water supply reliability in the Santa Margarita River Basin. Environmental studies began in November 2004.

  The project resulted from two unsuccessful attempts to build two dams on the Santa Margarita River, one of the last free-flowing rivers in Southern California. While the plan will increase diversions from the river, it is considered a superior alternative to new dams, water imports and further groundwater withdrawals.

- ***Tampa, FL - Desalination Delayed***

  The Tampa Bay desalination project is proposed to be the largest project of its kind in the United States. The project intends to use reverse osmosis technology to convert seawater into potable supply. The project was started in 1997 and first produced water in March 2003 at a cost roughly double that of groundwater sources.

  Two months after production started, performance tests uncovered more than 30 major deficiencies that allowed only "intermittent" operation of the plant since then. The current timetable has the plant resuming regular operation sometime in the spring of 2006.

- ***Orange County, CA - Recycling for Groundwater Enhancement and Protection***

  Years of groundwater withdrawals for agriculture and other uses have significantly drawn down Orange County's aquifers, resulting in increased mineral content in the groundwater and seawater intrusions into the aquifer. The Orange County Water District is constructing a water recycling system in order to remedy these problems, as well as create an additional water supply for this drought-prone region.

  Recycled water is considered a fundamental part of the water supply for many communities in the U.S., especially California. The project will take water that is currently dumped in the Pacific Ocean and treat it for local, beneficial reuse. In addition to help ing restore the health of the local aquifer, this project will help reduce damaging and energy intensive water diversion from Northern California and the Colorado River.

take extensive treatment to meet health standards for drinking water supplies. In response, other new technologies – such as the expanded use of various filtration membranes, as well as ozone and ultraviolet light disinfection technologies, among others – are currently under development for water and wastewater utilities and are being deployed to ensure compliance with regulatory standards and reduce operating costs.[iv]

Portland, OR - Green Streets for Pollution Prevention and Habitat Restoration

In 2002, the city of Portland embarked on an ambitious plan to eliminate combined sewer overflows into the Willamette River and protect endangered salmon by taking a new approach to drainage management. It adopted a "soft path" approach by adopting "the viewpoint of spawning fish, assess[ing] all aspects of road planning and design in terms of their affects on fish habitat."

The resulting Green Streets plan established street design guidelines for new development in a growing part of the Portland metro area and began a process of transforming the region's entire street system with the goal of restoring the area's natural hydrology. The plan employed a variety of methods, including stream buffers, expanded street trees, neighborhood greenways, wet ponds, stream restoration, and site-specific measures for parking lots and new developments that made stormwater management infrastructure a visible part of Portland's urban environment.

To better manage the non-point source pollution from urban stormwater, communities across the U.S. are looking to "soft path" approaches that rely on landscape features and advanced architectural materials and techniques to better manage water before it overwhelms their systems. Using a combination of watershed-appropriate tools like floodplain easements, wetlands, expanded street trees, bio-filtration corridors, and other stormwater diversion methods, it is possible to reduce the speed and volume of stormwater entering the system, thereby maximizing the efficiency of the infrastructure to prevent flooding from system overloads.

Financing, Affordability and Deferred System Maintenance

America's water systems are in a precarious state as years of deferred maintenance have taken a toll on the infrastructure. Most of the water systems in America's cities are decades, and in some cases hundreds of years, old. Cities across the U.S., both large and small, are facing a staggering bill in meeting this challenge. Moreover, the crumbling state of the nation's water distribution systems is contributing to countless gallons of water loss through leaks, just as supply concerns become more prevalent.

Clean water is not an expenditure of Federal funds; clean water is an investment in the future of our country.

U.S. Representative Bud Shuster

According to the American Water Works Association, our nation under-funds maintenance of and investment in our water and water infrastructure to the tune of $23 billion per year — $34 billion per year once financing costs are included in the calculation. In a survey conducted by the Government Accountability Office (GAO)[v], nearly three in 10 utilities deferred maintenance of their infrastructure because of insufficient funding. Over the next 20 years, more than $1 trillion will be needed to finance the operation, maintenance, and upgrading of the nation's water infrastructure. User charges will be insufficient to cover these costs without massive cost increases.

Alpaugh, CA - System Failure for Communities of Color

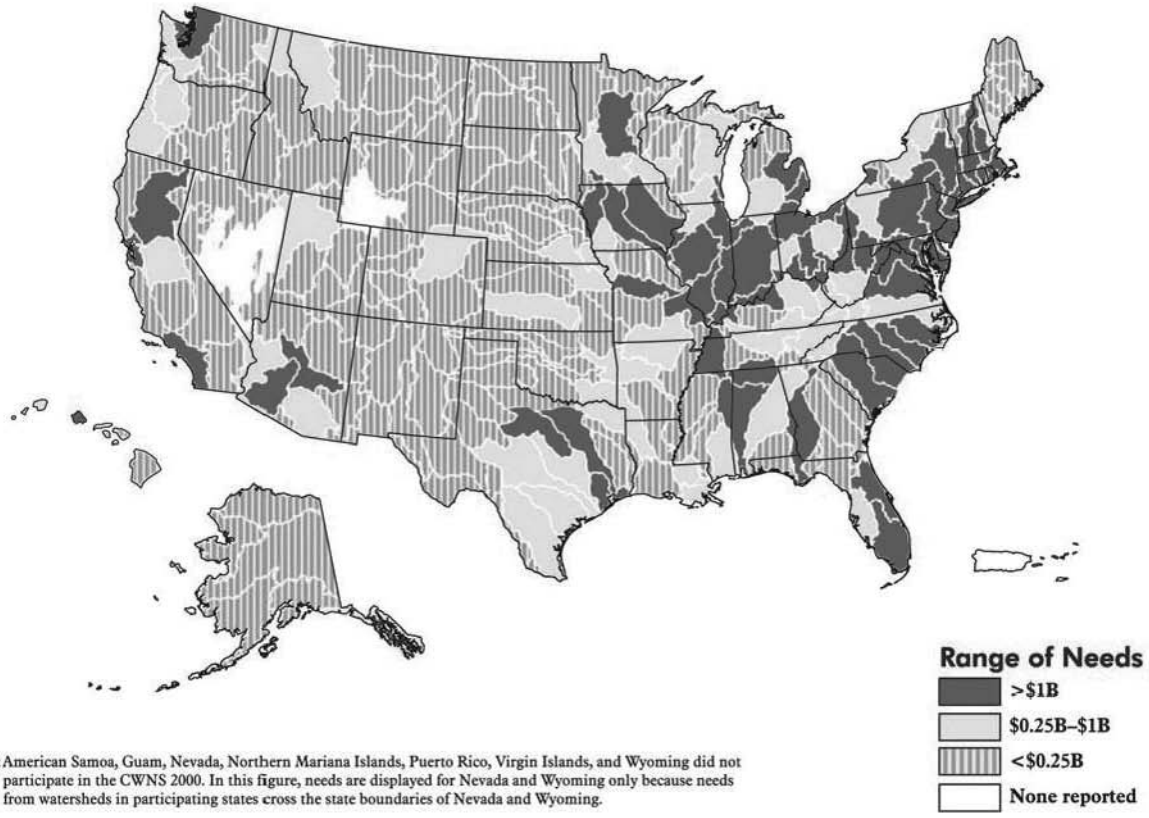
Alpaugh is a small community of about 760 people in southwestern Tulare County in California's San Joaquin Valley without a source of safe drinking water, despite being surrounded by hundreds of thousands of acres of irrigated cropland. Residents, many of whom are very low-income Latino farmworkers, have to rely either on trucked-in water or drive 20 miles into a neighboring town to fill up five-gallon jugs. Water costs can take up to 18 percent of a local person's income.

A pipe in the town's main deep well collapsed in 2003 while shallow groundwater is heavily contaminated with arsenic, pesticides and coliform bacteria. Although desperate residents temporarily relied on an irrigation well, the deeply subsidized irrigation water from joint state and federal water projects is kept for the crops — Tulare County ranks second in the United States in agricultural production. Three separate water agencies are responsible for the town's water. The drinking water authority did not have the money to fix the broken pipe, allowing that well to become contaminated. The Alpaugh Irrigation District hired a company to install a new deeper well but it went bankrupt, leaving the job half-finished and the well unsealed and exposed to possible contamination or tampering. The district delayed capping the half-finished well for budgetary reasons until a reporter from the *Los Angeles Times* began to investigate the story.

To date, more than $2 million has been provided by the state and federal government to upgrade Alpaugh's water system — largely in response to community pressure and intervention by state legislators. But there are hundreds of communities throughout the U.S. like Alpaugh that are too poor to afford necessary improvements to their water systems and too marginalized to receive adequate attention from large agencies.

Subsidized water rates to agriculture — particularly in the West and Southeast where the federal government has financed major water infrastructure projects — pull scarce resources away from other uses, such as improvements in infrastructure, while enabling wasteful use and ecosystem damage. Under century-old policies, the taxpayers have made what amounts to a decades-long, interest-free loan to what are mainly large agri-business corporations. Although these firms owe the Treasury a huge sum for their share of the cost of building the water project, they are not required to pay any interest as part of their irrigation bills and are allowed to reap massive profits from their sales of "rights" to deeply subsidized water diversions.

In addition to the costs of keeping up with ongoing and future needs, there remains a large backlog of investment to simply catch up with today's standards. The Clean Water Act invested almost $62 billion in communities large and small to rehabilitate aging sewer plants, minimize raw sewage overflows and reduce stormwater runoff. That investment has paid off, but much work remains to be done and funding for infrastructure and maintenance must be secured. In 1998, the EPA estimated that nearly $140 billion was still needed to do the job, an amount that has only increased since then.



Note: American Samoa, Guam, Nevada, Northern Mariana Islands, Puerto Rico, Virgin Islands, and Wyoming did not participate in the CWNS 2000. In this figure, needs are displayed for Nevada and Wyoming only because needs from watersheds in participating states cross the state boundaries of Nevada and Wyoming.

Figure 5-1. Geographic distribution of total documented needs by 4-digit watershed (January 2000 dollars in billions).

Private Grabs of Common Assets

The fiscal and management challenges facing water systems are leading public agencies to look to the private sector to operate or simply buy out – otherwise known as privatize – their systems. There are many different forms of privatization, ranging from outright ownership of the water and infrastructure to simply contract-out operation of a part of a community's water system. Yet regardless of the specific arrangement, privatization puts a commonly shared resource and essential infrastructure under the control of a private institution that is inherently insulated from democratic governance. Upward of 15 percent of U.S. water systems have been privatized and the private water sector already generates more than $80 billion in revenue — about four times Microsoft's sales.[vi] It is no wonder that *Fortune* magazine dubbed water the "oil of the 21st century."

> The time will come when they will sell you even your rain. At the moment it is still free, and I am in it. I celebrate its gratuity and its meaninglessness.
> **Thomas Merton,**
> **"Rain and the Rhinoceros"**

Proponents often claim that privatization promotes cost savings, increased capital investment and improved water quality. Their record often shows otherwise. Several major U.S. cities like Atlanta and New Orleans and a number of smaller ones have cancelled their privatization contracts when the promised cost savings simply did not materialize. Capital investment has often been shortchanged as these companies struggle to meet the bottom line for their shareholders, and since private companies are not entitled to the same low-cost financing as public entities (something they're trying to change through their lobbying efforts), they inherently have higher capital costs that must be either absorbed or passed on to customers.

Promises of improved water quality through privatization are also dubious. The National Association of Water Companies (NAWC), which represents the private water industry, intensively lobbies Congress and the EPA to, among the many items on its political wish list, block higher water standards. The NAWC also wants all federal regulations to be based on cost-benefit analysis, meaning that public health may be compromised for the sake of private profits. The organization believes, for example, that it is reasonable for water companies to spend more than $10 million to rid water of a contaminant only if doing so would likely save someone's life, but not if the contami-

nant poses serious but non-fatal health risks.[vii] More specifically, there have also been numerous documented water quality violations by private water companies throughout the U.S., which have resulted in boil orders for drinking water and discharges of raw sewage into waterways.

Public Accountability

America's public water systems clearly face massive fiscal, technical, and regulatory challenges in upcoming years that will require an intense effort and sustained investment to address. Public support and accountability are the linchpin to meeting these challenges. The trust of the people who own and pay for this infrastructure will be critical to seeing this effort through successfully.

The Perils of Privatization: Local Experiences with Privatization of Public Water Systems

- ***New Orleans, LA - Uncertainty Breeds Paralysis***
  New Orleans considered privatizing its water and wastewater for more than five years before finally abandoning the idea after running up costs of $5 million. The long debate created significant uncertainty for system managers and slowly ground workers' morale. More significantly, the uncertain atmosphere stymied the implementation of a slew of cost-saving measures developed by these same public servants.
- ***Indianapolis, IN - Failing Customers and Workers***
  Indianapolis is often touted as a privatization success story. A deeper look shows the success story to be an illusion. Customer dissatisfaction has risen since the system was privatized in 2002 as service declined and billing errors increased. Labor relations also suffered as workers nearly went on strike, veteran long-time employees were pressured into early retirement, and the National Labor Relations Board cited the private operator with 16 complaints for labor law violations.
- ***Atlanta, GA - Reversing Course after Empty Promises***
  Atlanta cancelled its privatization contract after city leaders became increasingly dissatisfied with four years of poor service and unmet promises. The city found evidence that its water contractor failed to perform maintenance, billed the city for work it didn't do, ignored customers' cries for service, cut staff to dangerously low levels, and occasionally delivered filthy, brown water. The contractor even asked the city for more money despite failing to fulfill its initial promises.

I understood when I was just a child that without water, everything dies. I didn't understand until much later that no one "owns" water. It might rise on your property, but it just passes through. You can use it, and abuse it, but it is not yours to own. It is part of the global commons, not "property" but part of our life support system.
Marq de Villiers, Water

Because water infrastructure is essentially invisible and only thought about when it is not working, the public often overlooks it. Moreover, for decades, water system planners treated the public as an afterthought as they designed these major infrastructure systems. Public disengagement and token involvement caused little concern as long as the federal government was picking up the tab for improvements, as it mostly did after passage of the

Clean Water Act. However, disengagement invariably leads to problems as unaware citizens show reluctance to pay for major system investments or measures to protect water sources — something that they will increasing be asked to do now that the responsibility of funding water system improvements has fallen more on to local rate and taxpayers.

Washington D.C. - Poisoned Water in the Nation's Capital

In late 2004, news reports revealed that lead levels in Washington D.C.'s drinking water greatly exceeded health standards. The Washington Water and Sewer Authority (WASA) and the EPA knew of this problem for almost two years without informing its customers.

Lead is especially poisonous to children, affecting the development of their brains, lowering IQs, and leading to a lifetime of health problems. In adults, lead exposure can cause brain and kidney damage. The problem is particularly problematic in older urban areas where exposure to lead paint significantly magnifies the health effects.

WASA has responded by sending out lead filters to its customers and beginning a massive lead pipe replacement program. However, citizens and clean water advocates call the response weak and demand more than $300 million in federal and local investment to fix the problems and adequately protect public health.

Ensuring that the utility's customers are treated properly and that their right of access to affordable, clean water is enforced is essential to maintaining the public's trust. However, citizens' rights to equal and dignified treatment in access to water are violated by many water utilities every day. Water utilities, both public and private, provide polluted water without informing customers – in violation of the provisions of the Safe Drinking Water Act. The *Washington Post* reports that more than 11.5 million people have water with unsafe lead levels. Others overcharge on bills and violate common procedural rules when consumers are late on payment, unable to pay or threatened to be cut-off from services. In America's large cities, it is not uncommon to find that up to 5 percent of customers are cut off from essential water services every year. In poorer cities like Detroit, the number is 15 percent.

Water Sustainability 101

It Is Central To Life

Water is a public good that is essential to life. It makes up 65 percent of our bodies and 75 percent of our brains, making our very existence dependent on it for basic health and survival. Water is also a necessary component to food production – from farms to fisheries. Our water systems serve as the lifelines for the metropolitan areas and their economies, where a majority of America's population resides and the majority of wealth is generated. Just as importantly, water serves a critical cultural role for Native American tribes.

> Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a pre-requisite to the realization of all other human rights.
> **The United Nations Committee on Economic, Cultural, and Social Rights**

Supplies Are Limited

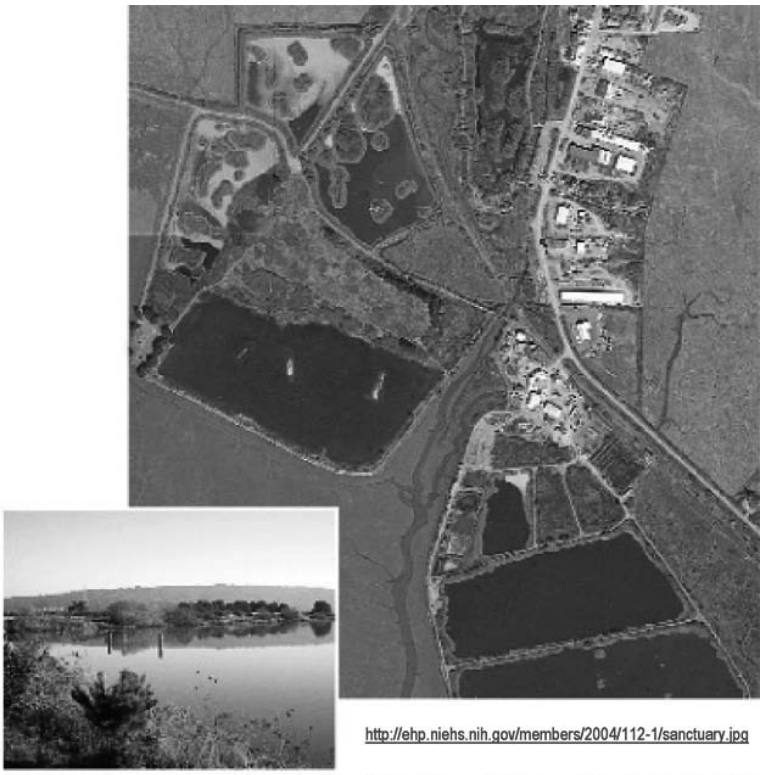
Less than 1 percent of the Earth's total water is available as fresh water; the rest is salt water, locked in ice caps or inaccessible. If all of the Earth's water were in a five-quart container, accessible freshwater would be not quite a teaspoon of that. Despite this global scarcity, the U.S. is incredibly rich in water resources with significant quantities of fresh water in the Great Lakes, as well as in the major river systems and in groundwater aquifers throughout the country. However, pollution, mismanagement, and overuse are threatening these supplies just as they are needed to meet population, environmental, and economic demands.

Infrastructure is Multifaceted

Water systems require both soft and hard infrastructure to operate at their optimum efficiency. Soft infrastructure is made up of the soils, wetlands, and vegetation that slow down, retain and treat water as it progresses through its natural cycle. Hard infrastructure for storage, delivery and treatment often has sig-

> The trouble with water — and there IS trouble with water — is that they're not making any more of it.
> **Marq de Villiers, Water**

nificant impacts on neighboring communities, wildlife and ecosystems. In urban areas, the infrastructure, particularly for wastewater treatment, takes on a large industrial character. In addition, the construction, operation, and maintenance of these large plumbing systems requires significant inputs of chemicals, lubricants and energy — for everything from pumping, transport, potable treatment and delivery, to wastewater treatment and recycling. About 4 percent of our nation's total electricity consumption is by water systems.



http://ehp.niehs.nih.gov/members/2004/112-1/sanctuary.jpg

The Arcata Marsh and Wildlife Sanctuary is the sewage treatment facility of the Northern California coastal city of Arcata. The restored wetland marsh sits on 300 acres of former lumber mill and pasture and treats an a verage 2.3 million gallons of sewage per day. In addition to treating the sewage for 20,000 people, it hosts thousands of visitors who come to picnic and watch the birds.

Waste Is Expensive

Waste, whether from loss through evaporation, poorly maintained infrastructure or through inefficient use, is extraordinarily expensive for water systems, the natural systems that rely on that water, and ultimately for customers. Evaporation from reservoirs results in less water running through rivers and streams, degrading their overall quality and harming their ecosystems. Leakage from crumbling infrastructure – whether from the source watersheds or in urban distribution systems – results not only in the loss of precious supplies but also the spending on treatment and transport costs that have to be recouped through higher charges. Inefficient end use magnifies these problems as it adds to wastewater collection and treatment expenses.

> We must treat water as if it were the most precious thing in the world, the most valuable natural resource. Be economical with water! Don't waste it! We still have time to do something about this problem before it is too late.
> **MIKHAIL GORBACHEV**

Protection Is Cost Effective

An ounce of prevention is worth a pound of cure. Protecting source watersheds and the integrity of the system infrastructure are cost-effective ways to ensure that water and the means to deliver and treat it are available to meet environmental and human needs now and in the future. Wise stewardship of source watersheds will help avoid treatment costs needed to ready the water for human consumption, reduce pressure to look for expensive outside water sources or invest in advanced treatment technologies, and provide direct local benefits. Regular ongoing maintenance of utility infrastructure will mitigate the effects of normal wear-and-tear and extend the life of the system, thereby preventing expensive, catastrophic failures and the need for massive capital rebuilding programs. A commitment to continual public involvement will protect the integrity of planning processes and help to protect against cost-increasing delays for necessary upgrades.

Pekin, IL - Planning for Groundwater Protection

Pekin is a community of more than 33,000 people in central Illinois that relies on groundwater for all of its water needs. To protect its water supply, the community has taken additional steps beyond the state's mandated monitoring activities.

- A groundwater protection ordinance was used to impact the planning of several site plans for new and existing businesses. A countywide groundwater protection ordinance is in development.
- To complement the protection ordinance, a geographic information system mapping project was completed to determine setback and recharge areas.
- A Groundwater Education Committee was formed to implement the recommendations of the Illinois Environmental Protection Agency's Pilot Needs Assessment. A booth was set up at a variety of conferences, business expositions and educational fairs. Presentations were given to classes in the Pekin school system.
- Street signs were installed to mark the location of the recharge areas for the city's wells and to alert citizens that they are entering sensitive recharge areas.
- A Contingency Plan was developed with the city fire department to provide an emergency response plan in the event of a hazardous or special waste spill in a recharge area.

A New Approach to Water Management

The Old Paradigm	The Emerging Paradigm
Human waste is a nuisance It is to be disposed of after the minimum required treatment to reduce its harmful properties.	***Human waste is a resource*** It should be captured and processed effectively, and used to nourish land and crops.
Stormwater is a nuisance Convey stormwater away from developed areas as rapidly as possible.	***Stormwater is a resource*** Harvest stormwater as a water supply, and retain or infiltrate it to support aquifers, waterways and vegetation.
Build to demand It is necessary to build more capacity as demand increases.	***Manage demand*** Demand management opportunities are real and increasing. Take advantage of all cost-effective options before increasing infrastructure capacity.
Demand is a matter of quantity The amount of water required or produced by water end-users is the only end-use parameter relevant to infrastructure choices. Treat all supply-side water to potable standards, and collect all wastewater for treatment in one system.	***Demand is multi-faceted*** Infrastructure choices should match the varying characteristics of water required or produced by different end-users: quantity, quality (biological, chemical, physical), level of reliability, etc.
One use (throughput) Water follows a one-way path from supply, to a single use, to treatment and disposal to the environment.	***Reuse and reclamation*** Water can be used multiple times, by cascading it from higher to lower-quality needs (e.g., using household graywater for irrigation or toilet flushing), and by reclamation treatment for return to the supply side of the infrastructure.
Gray infrastructure The only things we call infrastructure are made of concrete, metal and plastic.	***Green infrastructure*** Besides pipes and treatment plants, infrastructure includes the natural capacities of soil and vegetation to absorb and treat water.
Bigger/centralized is better Larger systems, especially treatment plants, attain economies of scale.	***Small/decentralized is possible, often desirable*** Small-scale systems are effective and can be economic, especially when diseconomies of scale in conventional distribution/collection networks are considered.
Limit complexity: employ standard solutions A small number of technologies, well-known by water professionals, defines the range of responsible infrastructure choices.	***Allow diverse solutions*** A multiplicity of situation-tuned solutions is required in increasingly complex and resource-limited human environments, and enabled by new management technologies and strategies.
Integration by accident Water supply, stormwater, and wastewater systems may be managed by the same agency as a matter of local historic happenstance. Physically, however, the systems should be separated.	***Physical and institutional integration by design*** Important linkages can and should be made between physical infrastructures for water supply, stormwater and wastewater management. Realizing the benefits of integration requires highly coordinated management.
Collaboration = public relations Approach other agencies and the public when approval of pre-chosen solutions is required.	***Collaboration = engagement*** Enlist other agencies and the public in the search for effective, multi-benefit solutions.

Source: Rocky Mountain Institute, http://www.rmi.org/sitepages/pid279.php

Five Steps to System Wisdom and Sustainability

Protect Natural Capital

Growing demand will place greater pressure on watersheds, rivers, lakes and groundwater sources. As these fundamental stores of natural capital are degraded and depleted, the water we need will be harder to come by and more expensive to make usable for human consumption. Protecting these sources is the most effective way to preserve our natural heritage, avoid steep, future expenses, and ensure that water is available when and where it is needed.

Protecting our natural capital relies on the cornerstone of pollution prevention, and demands a toolbox of strategies tailored to the regions where they are to be implemented. In order to protect surface waters, priority must be given to reducing agricultural and urban runoff and combined sewer overflows, particularly because many communities and jurisdictions are likely to draw from the same source. Where groundwater makes up the bulk of water sources, extra attention must be given to preventing groundwater pollution, promoting recharge and

New York City - The Watershed Protection Alternative to Major Capital Expenditures

The New York City Water Supply System (NYCWSS) delivers an average of 1.5 billion gallons per day to more than 9 million people in New York City and neighboring communities. In 1997, the NYCWSS entered into an agreement with the EPA and over 70 other major stakeholders to avoid multi-billion dollar drinking water filtration upgrades for its 2000-square-mile watershed. Rather than spend scarce funds to treat the water, the NYCWSS understood that it could achieve the same objectives by protecting nature's filtration system and preventing the pollution in the first place.

The result was an innovative program that relies on a combination of measures including land acquisition and stewardship, enhanced regulatory enforcement within the watershed, partnerships with other watershed stakeholders, and public education and outreach. To date, with financial commitments from New York City and additional support from the state of New York, the program has:

- Reached out to owners of more than 281,000 acres to begin land acquisition.
- Purchased or placed under contract more than 28,000 acres of watershed lands.
- Contracted for 2,800 acres of agricultural easements.
- Opened nearly 35,000 acres to fishing and hiking.
- Improved over 1,300 failing septic systems and 30 winter deicing materials storage facilities.
- Began upgrades of 34 non-city-owned wastewater treatment plants.
- Begun education and outreach efforts to watershed residents, technical professionals in stormwater, wetlands, and stream corridor management, and local college students and other constituents.

percolation, and preventing overdrafts. As more water is moved from one major watershed into another, importers of water not only need to protect their watersheds, but also ensure that the above measures apply for both source and user watersheds.

Hard limits on total water withdrawals are an indispensable component of protecting the natural capital that constitutes nature's water filtration and distribution system. Excessive withdrawal of water from either groundwater aquifers or surface sources lowers the water table and has the potential to affect the available amounts of surface water. Pulling too much water out of rivers and lakes impacts water quality and harms both wildlife and the economies that depend on healthy water bodies.

- Develop long-supply plan that calculates the "ecological carrying capacity" of source watersheds and ensures that it is not exceeded.
- Identify sensitive areas in the watershed that may affect groundwater and surface sources and take steps to protect them from development.
- Promote alternatives and special guidelines for pesticide use in order to reduce polluting runoff.
- Enforce water pollution prevention laws with outreach and education programs and strong penalties for repeat violators
- I ncorporate diversion and infiltration strategies to reduce combined sewer overflows and non-point source pollution in urban and urbanizing areas.

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Encourage Efficiency and Recycling

Dramatic reductions in per capita water use will be necessary for long-term stewardship of our natural capital, as well as to keep up with the population growth that will drive water demand. Measures that include end-use efficiency, stormwater harvesting, and advanced recycling must all be part of the toolbox to reduce demand by domestic, agricultural, commercial and industrial users. Water recovered through conservation and efficiency measures is often the least expensive supply source and offers the greatest opportunity to increase the available water to meet the needs of humans and ecosystems.

Stormwater harvesting systems can cost-effectively prevent urban runoff as they collect clean rainwater for use in clothes washing, toilet flushing, irrigation and even groundwater recharge.

Measures to reduce domestic use – such as low-flush toilets, stormwater capture systems and changes in wasteful consumption habits – are of vital importance, and can save as much as 30 percent of water used for domestic purposes. However, efficiency measures for agriculture are even more urgently needed. A similar 30 percent reduction in agricultural use would make available more than twice the amount of water used domestically. Conservation efforts such as drip irrigation

technology, combined with other water efficient agricultural practices, could dramatically decrease agricultural water requirements while improving long-term food security.

Commercial and industrial users can also make dramatic reductions in their water demands. For example, waterless urinals and automatic water control devices on faucets in office buildings, hotels, shopping centers and other public spaces can save millions of gallons per day across the United States. Dry cooling technologies can significantly reduce the water needs for power generation, which consumes nearly three times more fresh water than all of the public systems and domestic groundwater withdrawals for more than 290 million people.

This row of waterless urinals saves thousands of gallons of water per day while improving hygiene for users and reducing maintenance costs for owners.

Recycled water of varying quality levels can replace fresh water supplied for agricultural, industrial, and commercial purposes in irrigation, process or cooling. Ultra high-quality, recycled water can be used for indirect potable purposes such as groundwater aquifer recharge to raise water tables and prevent saltwater intrusion in coastal areas. Recycled water treated to less stringent, but still health-protective, standards can be used for toilet flushing, industrial processing and cooling, irrigation, ecological restoration, and other non-potable uses.

- Conduct thorough "water use audits" of a system's users - both large and small - to identify opportunities for waste reduction and efficiency retrofits.
- Implement aggressive efficiency and conservation programs using a combination of incentives, targeted retrofits, pricing tools, and culturally-appropriate public education.
- Reduce agricultural water demand through advanced irrigation systems, strategic land retirement, and replacement of high water-demanding crops.
- Maximize water recycling/reclamation as a source for irrigation, industrial and commercial demand.
- Encourage stormwater harvesting for on-site irrigation reuse and graywater systems for residential toilet flushing and landscape irrigation.

Maintain Flexibility and Resiliency

Infrastructure improvements must be made strategically in order to give water systems the flexibility and resilience they need to adapt to changing circumstances and prevent expensive and wasteful over-building. Developing strategic redundancy provides managers with flexibility to take key systems offline for timely maintenance and improvements to extend the life of critical infrastructure and forestall expensive, capital improvement programs.

Water and wastewater treatment technology has reached the point that significant economies of scale can be realized in smaller facilities than in times past. This allows for a new level of flexibility that permits system planners (particularly in growing areas) to appropriately size facilities to meet mid-term needs, without overbuilding, and in turn trigger growth-inducing effects that may lead to an overwhelming of that same infrastructure. Furthermore, smaller networked systems may provide an extra level of flexibility for maintenance and assurance for security.

The emergence of new technologies and integrated, water management approaches has made it possible to break up large systems into smaller, appropriately scaled, and responsive units that achieve more efficient operational goals. As older infrastructure is upgraded and replaced, the possibility is open to makes these alternatives feasible. This holds true for an entire water system, from source to wastewater treatment and recycling. While there exists “toolboxes” for a variety of scenarios, specific decisions should be based on a particular community’s land-use mix and other geographic features, as well as a water system’s technical characteristics.

- Assess the cost of service to ensure that the utility's pricing structure brings in sufficient revenue to operate, maintain and continually improve the system.
- Dedicate a portion of system revenues to preventative maintenance in order to reduce the risk of catastrophic failures and resulting costly capital expenditures.
- Avoid overbuilding by investing in decentralized solutions that are scaled to their intended uses.
- Promote diverse and incremental solutions that work together to provide redundancy for water supply and waste water treatment.

Ensure Equity

Water's importance and the scale of the impacts from infrastructure systems require that special care be taken to ensure equity for stakeholders. Customers, facility neighbors, residents of source watersheds, and others have a right to be free from overly burdensome expenses and disproportionate pollution.

Low-income families and communities can be especially affected by poor water quality, high prices, and degraded infrastructure since they are unable to neither bear the debt load of significant capital investment nor afford to look for other sources for their water supplies. The lack of effective wastewater treatment causes further damage as groundwater and surface water supplies become polluted. This downward cycle ultimately affects local and regional public health and economic performance and is often extremely expensive to break out from without significant external financial support.

Efforts should also be made to reduce the impacts on facility neighbors, especially in urban areas where communities of color or low-income are often adjacent to massive, industrial facilities with air emissions and odors. The need to remove and dispose of biosolids generates hundreds of weekly truck trips, further escalating air emissions. In agricultural communities, groundwater pumping by diesel-powered pumps burdens neighbors living close to the fields with carcinogenic diesel emissions. Appropriate measures should also be taken to first avoid or otherwise reduce the impacts of diversions on source watersheds and their residents. The effects of excessive diversions can have widespread impacts, including damage to fish populations, habitat loss and even degraded air quality.

- Ensure affordable access to clean drinking water and wastewater treatment.
- Protect water quality in rivers and lakes to reduce disproportionate environmental impacts on subsistence fishers, as well as preserve recreational opportunities for all citizens.
- Mitigate the impacts of hard water system infrastructure on neighboring communities.
- Involve customers and impacted stakeholders in the long-term planning of system improvements and upgrades.

Govern Responsibly

Responsible stewardship of our common assets is a theme that runs throughout this handbook. Good governance that values employees, respects customers, and involves the public in major planning decisions is often the cornerstone that makes the investments discussed in this handbook possible.

Valuing the contribution of the workers who operate and maintain our water infrastructure is a key aspect of good governance. These public employees are priceless resources for the smooth functioning of these necessary systems and indispensable to the long-term effort of stewardship of our water infrastructure. Involving front-line workers in system planning and management can pay big dividends as they identify inefficiencies and develop solutions to operational issues. Furthermore, because these individuals are often times rooted in the communities in which they work, they have significant stakes in the health of the water systems that they help maintain.

A water utility's primary responsibility to its stakeholders is to reliably provide affordable and clean water and manage the wastewater generated through that use. Customers must be provided with assurance that the water utility is doing its utmost to safeguard their health, be efficient with their ratepayer dollars, and get water to all who need it. Public communications that provide regular updates on the utility's activities and challenges will help build confidence that the agency is doing all it can to meet the needs of its customers.

Respecting customers and involving them in strategic planning can also pay dividends in terms of long-term system health. The scope of the total historic under-investment in our water infrastructure and projected population growth virtually guarantee that significant capital improvement programs will be needed. In places where voter approval is required to issue general obligation or revenue bonds, effective public involvement can go a long way to securing the public support needed to pass the measures. For example, Phoenix has achieved a near 100 percent approval rate for its capital improvement bond measures as a result of an aggressive public involvement program that routinely brings in over 200 active participants in the project planning and prioritization.

- Treat water resources and related infrastructure as public trusts that must be protected for future generations.
- Develop asset management plans that ensure the timely maintenance and replacement of infrastructure.
- Fully inform citizens about drinking and source water quality.
- Identify efficiencies in system operations through collaborative efforts with system workers and managers.
- Develop progressive pricing structures to ensure both universal access for customers and cost recovery for the system.
- Work with lawmakers to secure federal and state appropriations for water infrastructure investments.

Conclusion

This primer represents the beginning of a long-term effort to build the capacity of local decision makers to be effective stewards of our water commons – the natural resources and publicly built and controlled water infrastructure that make possible our modern society. It recognizes that while communities are extraordinarily diverse and must contend with their own particular circumstances, they share similar concerns and aspirations and can adopt similar solutions to their common problems. Yet it only scratches the surface of the complexities involved in confronting our water challenges. Our nation has invested billions of dollars in creating the current situation and it will take years to transform our water systems to fully reflect our ideals. It will require cutting-edge, technical research, ongoing education and training, and a tenacious commitment to long-term institutional change. This is a first step.

Additional Resources

National Public Interest Advocates

Campaign for Safe and Affordable Drinking Water (www.safe-drinking-water.org/)

Common Assets Defense Fund (www.commonassets.org)

Center for Watershed Protection (http://www.cwp.org)

Clean Water Action (www.cleanwateraction.org)

Clean Water Fund (www.cleanwaterfund.org)

Clean Water Network (www.cwn.org)

Natural Resources Defense Council (www.nrdc.org)

Pacific Institute for Studies in Development, Environment, and Security (www.pacinst.org)

Public Citizen Water for All Campaign (www.wateractivist.org)

Rocky Mountain Institute (www.rmi.org)

Sierra Club (www.sierraclub.org)

Surfrider Foundation (www.surfrider.org)

Waterkeeper Alliance (www.waterkeeper.org)

Watermap (www.watermap.org)

The World's Water (www.worldwater.org)

Industry and Professional Associations

American Society of Civil Engineers (www.asce.org)

Association of Metropolitan Water Agencies (www.amwa.net)

Association of Municipal Sewerage Agencies (www.amsa-cleanwater.org)

American Water Works Association (www.awwa.org)

Water and Environment Federation (www.wef.org)

Public Agencies and Regulators

U.S. Environmental Protection Agency Water Site (www.epa.gov/OW/index.html)

U.S. Environmental Protection Agency Watershed Academy (http://www.epa.gov/watertrain)

U.S. Geological Survey Water Site (http://water.usgs.gov/)

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