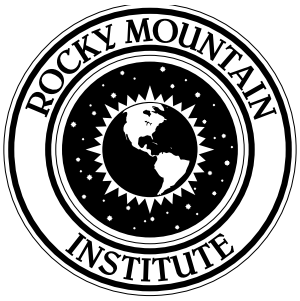
WATER 2010

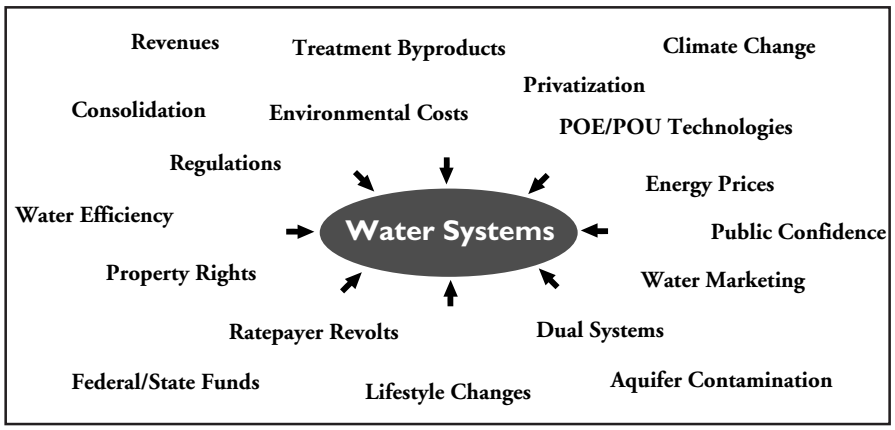
Four Scenarios for 21st Century Water Systems



By: Richard Pinkham
and
Scott Chaplin
Rocky Mountain Institute

Contents

Introduction: Taking the Long View



How will these and other factors combine to shape future water systems?

Few people spend much time deeply examining the future. Daily chores and present crises consume the time of most water managers, water utility board members, and citizens. Even water system planning staff, charged with anticipating the future, spend much of their time looking at the present and the past—extrapolation from historic data is a common planning methodology. Projections have their place, but persons concerned with the future of water systems need tools for grappling with the changes and uncertainties inherent in the future, tools that can reveal how a variety of forces operating across society—changes in values, demographics, technologies, policies, and economies—may create, shape, or arrest important trends. Scenario building is one such tool. It provides a means of going beyond simple extrapolations to envision a variety of plausible futures, thus improving one's ability to plan for change and surprise.

Here are just a few of the challenges and uncertainties facing municipal water systems* today:

- Government actions in many key areas—regulation of drinking-water quality and wastewater effluent, oversight of utility water pricing and management practices, water allocation, etc.—are hard to predict, particularly given recent political changes in Washington, D.C. and around the country.

- The costs of maintaining and improving infrastructure are increasing, and some sources of funds, such as federal grants and loans, are in doubt. Changes in private capital markets are also under way.

- Public confidence in the quality of drinking water may be declining, as evidenced by the attention given recent outbreaks of cryptosporidium and other pathogens in some municipal systems, and by the growth of the bottled-water and home-treatment industries.

- Water demands of municipal and non-municipal water users alike are evolving, with important implications for municipal supplies.

- Water-efficiency measures and improved treatment technologies provide new alternatives to conventional approaches to water supply and water and wastewater treatment.

The scenarios in this report are intended to illuminate four possible ways these and other forces could affect the future of municipal water systems. No one knows for certain how the many pieces will come together, and any single vision is likely to miss the mark in important ways. The beauty of developing a range of scenarios is that they can capture a variety of plausible, important, and sometimes surprising interactions between driving forces. Peter Schwartz, a renowned expert on scenario building and author of *The Art of the Long View*, explains scenarios this way:

> Scenarios are a tool for helping us to take a long view in a world of great uncertainty. The name comes from the theatrical term "scenario"—the script for a film or play. Scenarios are stories about the way the world might turn out tomorrow, stories that can help us recognize and adapt to changing aspects of our present environment. They form a method for articulating different pathways that might exist for you tomorrow, and finding your appropriate movements down each of those possible paths.[1]

* Throughout this report, the term "municipal water systems" is intended to comprise small town and city systems to large metropolitan systems. It includes publicly and privately owned systems, and drinking water, wastewater, and combined systems. The term "water utility" has a similarly broad meaning as used in this document.

Scenarios are not predictions. Each of the four scenarios presented in this report is an image of one possible future. Each is plausible given current and emerging trends and potential developments. None is presented as "most likely." To do so would short-circuit the examination and discussion the scenarios are designed to engender.

Some readers may be familiar with the dry, highly analytic, densely documented scenarios sometimes developed by the military, large corporations, think tanks, and others. Charts and graphs and projections characterize such scenarios. The scenarios in this report take a different approach. They are presented as narratives—stories about the future—because the narrative form allows a degree of contextual development that often engages interest more readily than academic scenarios.

This approach to scenario building is increasingly used by corporations to improve strategic decision-making. Royal Dutch/Shell Oil pioneered this technique to anticipate the oil price shocks of the 1970s and the price collapses of the mid- to late 1980s, dramatically increasing the company's profitability. Smaller companies have used the technique as well: Smith and Hawken used scenarios to develop gardening and apparel product lines and marketing strategies that made it one of the fastest-growing companies of the 1980s.

In 1994, the Futures Studies Group of the U.S. Environmental Protection Agency asked Rocky Mountain Institute to apply scenario-building methodology to the future of municipal water services in the United States. This project grew out of a 1992 EPA workshop that gathered several dozen water experts to discuss the factors—technological, economic, environmental, social, and political—that will shape the future of municipal water systems. Rocky Mountain Institute reviewed the results of that workshop, undertook additional research, and with the help of a broadly based team of peer reviewers, prepared the scenarios in this report.

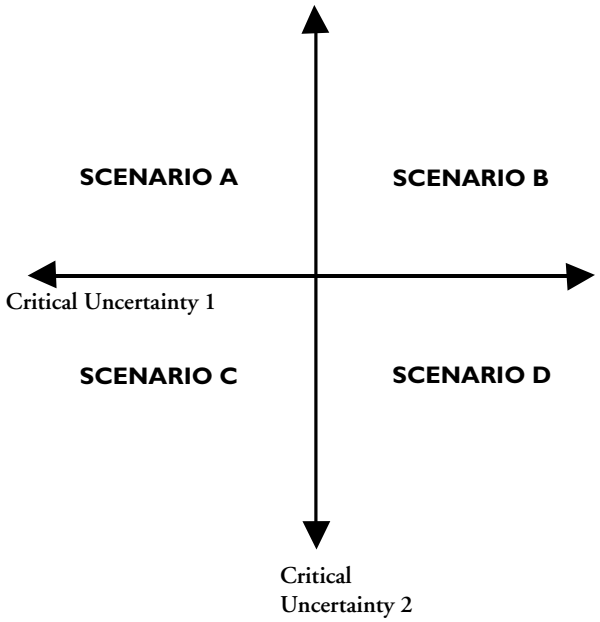
The result is a set of scenarios illustrating challenges facing water systems in the year 2010. While the project focuses on urban and small city systems, the implications of the scenarios should be of interest to persons concerned with other water sectors as well. The exact year of the scenarios is not so important; what matters are the potential changes that are highlighted. The year 2010 is beyond the millennial divide—and psychological barrier—of the year 2000, but well within the career spans of many current water managers and policy makers. What surprises will these next 15 years bring?

No one can say for sure. The purpose of this effort is not to predict one most probable future. After all, the future is rarely what any particular group of experts thinks it will be. These scenarios are intended to generate dialogue about the forces that will impact U.S. water systems, especially those forces that water managers, regulators, and users cannot themselves control. By presenting visions of several different ways important forces may play out, we hope to spark critical reflection on common assumptions about the future, and discussion of strategies for addressing changing times. These scenarios ask of the water managers, government officials, and citizens who may read them: What is your own vision of the future? Are you prepared for the future to turn out differently?

Two Critical Uncertainties

In examining the future, one is confronted with myriad forces, factors, trends, and potential events to consider. One cannot hope to evaluate all possible combinations of forces. The dimensions of uncertainty are simply too many.

A common approach to scenario building is to choose two driving forces that are both very important *and* uncertain or unpredictable. For each of these two "critical uncertainties," one then assumes two different but plausible future outcomes. Combining the two outcomes for the two forces yields a scenario matrix of four different futures.



For each critical uncertainty, the two assumed outcomes must be plausible, but sufficiently divergent that the scenarios will highlight different risks and opportunities presented by the uncertainties. Each outcome is also typically somewhat "generic": the objective is to capture its essence, not to narrowly constrain it. Additional forces can then be incorporated into each scenario in ways that fit plausibly with the overall pattern established by each combination of outcomes.

The two critical dimensions of uncertainty we have chosen for this scenario set are:

- The federal government's role in water management.
- The future nature of the financial environment—i.e., the availability and cost of capital and the public's willingness to support investments in system maintenance, expansion, and improvement.

These two drivers and the assumed outcomes for each are discussed in more detail below.

The Federal Role

This dimension of uncertainty was chosen in order to explore questions concerning the federal government's future regulatory, policy-making, and managerial powers and responsibilities.

Municipal water systems currently operate within the parameters of numerous, complex, and sometimes conflicting water-quality regulations. These regulations have become both broader and stricter over the past several decades, most often as the result of federal legislation and standard-setting. Concerns over the appropriateness of certain regulations, and the ability of some systems to meet requirements, have increased in recent years. The direction of federal regulatory policy is unclear in the short term, as exemplified by debates around the long-overdue reauthorizations of the Clean Water Act and the Safe Drinking Water Act. The federal role is also unclear in the long run—the division of powers between federal, state, and local governments has been a central subject of American political debate since the nation's founding. To many minds, recent changes in the control of Congress indicate that the nature of the federal government's regulatory role is far from settled and is quite likely to change in important ways.

Future federal involvement in water-quantity management is also unclear. Water rights have typically been considered to be under the control of the states. But the nature of that control has been muddied by federal assertion of reserved rights in the West, federal obligations to Canada and Mexico, and by the inevitable connections between water quantity and water quality nationwide, since federal water-quality standards and other environmental requirements can constrain the ability of states to allocate water. Historically, of course, the federal government has played another, and very large, role in water allocation. Across the country, dams, locks, water-supply canals, and other structures built and operated by the federal government are key to management of the nation's water. Movements to shift management and even ownership of many of these systems to lower levels of government, and in some cases the private sector, have accelerated recently, but it is not at all clear how far such efforts will get.

Federal involvement in water management has also included a wide range of research, data collection, information dissemination, and other functions. What kind of research and service capabilities the federal government will maintain or develop in the future is not clear.

Whither the federal role? For two of our scenarios, we have chosen to characterize it as *dominant*. In such futures, the fed-

eral government would continue to take the lead on standard-setting and would have strong involvement in enforcement, water allocation, and other matters. For our other two scenarios, we envision a *reduced* federal role. These futures attempt to capture the potential devolution of some federal powers, responsibilities, and functions, whether such changes are driven by anti-government sentiments or by efforts toward greater cooperation and partnerships between the federal government and states, local governments, and the private sector. Clearly these characterizations are oversimplifications of the possible directions for federal policy and action, but they serve as useful starting points for building the scenarios.

The Financial Environment

Municipal water systems are very capital-intensive. Construction, improvement, and replacement of water storage and diversion facilities, treatment plants, pumping stations, and distribution and collection lines require major investments.

Substantial capital requirements to meet regulations, accommodate growth, and address deferred maintenance are anticipated in the coming decades. On the wastewater side, the EPA has estimated that $137 billion will be required over the next 20 years for publicly owned treatment works, line maintenance and rehabilitation, new sewage collector and interceptor lines, management of combined sewer overflows, and other related needs.[2]

Capital needs are also considerable for drinking-water systems. Studies have projected needs ranging from $3.7 to $12.0 billion annually over the next several decades.[3] These needs can be traced to a variety of factors, including improvements directly related to the Safe Drinking Water Act, costs for deferred maintenance that must be addressed as systems come into compliance with the Act, and satisfaction of demand growth and other infrastructure needs unrelated to the Act.[4] Deferred maintenance is a particularly troubling aspect. For instance, municipal water systems now spend an estimated $1.7 billion annually to replace water-distribution pipes, but at current replacement rates, any given pipe will only be replaced once every 200 years. If utilities are to maintain water-system serviceability, the rate of replacement must be substantially increased.[5]

Both the availability and cost of capital will be significant concerns for water systems in the coming years. The reasons are many:[6]

- Consumers are more circumspect about increasing costs. The potential for "rate shock"—which could reduce the ability of utilities to use the rate structure to raise funds, service debt, or provide returns on equity—is real.

- Those utilities that hope to support capital investments with local, state, or federal government funds may find such sources drying up as governments face budget shortfalls and increasingly difficult choices in allocating funds to the many public services and programs seeking them.

- Difficulties in the banking and savings and loan industries have reduced the availability of commercial bank loans.

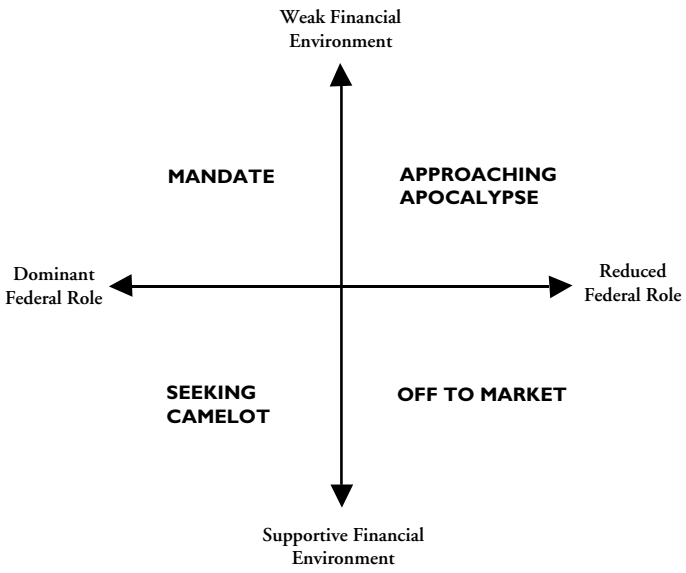
- Investors perceive increased risks in water utility securities. Uncertainty over the nature and future course of regulation, increased construction risks associated with more complex systems, potential revenue losses due to water shortages or increased conservation, growing consumer activism, and many other factors contribute to increased investment risks. The implications for water utilities are greater difficulty securing capital, and higher costs for that capital. To these developments might be added the globalization of capital markets: increasingly water utilities will have to compete for capital with other potential investments around the globe, many of which yield considerably higher returns than traditional water-sector investments.

These changes are well under way, but exactly how they will play out and affect water utilities is unclear. Thus the nature of the financial environment for municipal water systems is the second critical uncertainty around which the scenarios in this report are built. Difficulties for many systems seem certain, but how deep might the problems run? Innovative financing techniques may mitigate some problems. Also, clean water is a vital commodity; supporting needed investments could become a priority expenditure for governments and water ratepayers. Much may depend on the general future state of the economy.

In this report, we have chosen to envision two scenarios with generally *weak* financial environments, where many utilities have difficulty in obtaining and affording capital. In the remaining two scenarios, we have envisioned generally *supportive* financial environments in which capital is relatively available and affordable, and increased costs are mostly tolerated by ratepayers.

A Scenario Matrix

Combinations of these two critical uncertainties—the federal role in water management (dominant or reduced) and the financial environment (weak or supportive)—establish the general structures of the four scenarios in this report, as portrayed graphically below. The scenario names are intended to capture the general nature of each scenario in an evocative, memorable label.



Fleshing Out the Scenarios

Many other factors will influence the future of municipal water systems besides the two critical uncertainties. Some of the factors addressed in the scenarios in this report include:

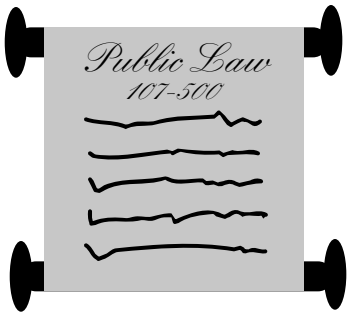
- Public attitudes toward protecting the environment.
- Public concerns about the safety of drinking water.
- Regional patterns of growth resulting from increased population and migration.
- Changing per-capita water demand.
- Competition for water with environmental, agricultural, and other uses.
- Developments in water-treatment technology, information systems, and other areas.

Some of these factors, and others not listed above, are likely to play out one way given one combination of federal role and financial environment, and a different way given another combination. Thus the four scenarios revolve around the critical uncertainties, but also show how a variety of other trends and developments might contribute to or evolve from the different combinations. As the scenarios were built, each began to take on a life of its own and develop a unique thrust or emphasis. Thus, the scenarios do not all consider exactly the same set of factors. Also, the order and style of development varies a bit in each.

Here then are four ways the municipal water world could look in the future, from the perspective of the year 2010. None is a prediction, and the future is unlikely to resemble any one scenario precisely. Also, these short narratives cannot hope to encompass all the existing and developing variations between regions of the United States and types of systems. But the overall stories these scenarios tell should help water managers, government officials, and concerned citizens understand the interplay of forces and the influence of surprises in the actual future that unfolds over the next 15 years.

Mandate

Dominant Federal Role
Weak Financial Environment



It's 2010, and federal agencies maintain high standards for water quality and environmental protection. But enforcement activities are underfunded, and coordination with state and local governments is difficult. Budgets at all levels of government are severely pinched. Citizens demand high standards out of concern for public health and the environment, but they are so overburdened by taxes and the high cost of living that they resist rate increases necessary to support water system improvements.

Restless America

The second half of the 1990s saw the electorate grow increasingly restless. Globalization of the economy benefited the affluent and highly educated, but many American workers saw their wages stagnate or decline as the country competed against cheap labor—both blue and white collar—in international markets. Many voters turned against free-trade politicians, and many came to see the social program cuts of the mid-1990s as a mistake. Popular discontent grew with increasing underemployment and higher levels of homelessness and urban decay. Most Americans grew cynical about federal tax cuts; they felt the tax burden had only been shifted from the federal to state and local levels, and from the more affluent to the working class.

Fed-up voters returned to power politicians who advocated strong federal action. Protectionist policies were enacted, social programs were refunded, and deficit spending increased. Federal taxes rose. The Federal Reserve was pressured to loosen the money supply to spur economic growth. Inflation began to creep up again. Real discretionary income continued to fall for most Americans. As the new century opened and progressed, few felt that the economy was really getting any better.

Some political analysts expected voters to demand a new round of federal government downsizing. But baby boomers were increasingly the generation in power. While not the radicals they once were, their concerns for social and environmental issues were still strong. As their clout increased, these children of the '60s supported strong federal programs for the poor and for their own health care. They also demanded new environmental protections and strict regulations to keep organisms and toxics out of their water and their aging bodies. They wanted pure drinking water, and ample clean water in the rivers and lakes where they recreated and planned to retire.

Big Sails, No Wind

Public health and environmental laws and regulations in 2010 are strong. There are requirements for extensive water-quality monitoring, replacement of aging treatment plants with the best available technology, integrated resources planning, strict control of non-point pollution sources, and more. But the money to support these demands is hard to come by. Faced with their approaching retirements, increasing health care costs, and a struggling economy, much of the public has a low tolerance for rate increases to support new or improved drinking-water and wastewater treatment facilities. Federal aid is not forthcoming either. With the continuing deficit problem, and with most of the federal budget committed to social programs and interest payments on the federal debt, little funding is available to support federal water programs and the infrastructure improvements they require. Many "unfunded mandates," which had gone away in the mid-1990s, are back in the new Washington—politicians once again pass tough health and environmental laws to show they are protecting the people, but remain vague about how to fund the new requirements.

State and local governments are strapped as well; voters have resisted further tax increases at these levels, too. As a result, agencies at all levels of government often turn to educational programs as an inexpensive way to "do something." Stiff fines against polluters are also popular. They provide one revenue-raising mechanism supported by most of the public.

One Step Forward, Two Steps Back

Water conservation has become something of a national crusade over the past decade. Increased efficiency in water use is promoted by federal and state governments and utilities alike as a low-cost way to defer expensive capacity expansions. Natural turnover in fixtures, aggressive promotion of fixture retrofits, graywater systems, efficient washing machines, and strict efficiency requirements for new development have led to a reduction in per-capita residential water use of nearly 35% since 1995. Demographic changes have also contributed to this reduction. Increasing numbers of citizens live in group housing, such as nursing homes and public housing, where budget-conscious managers strive for efficiency with both indoor and outdoor water use.

Changing internal U.S. migration patterns and new quotas on immigration have altered the regional distribution of various water problems. Movement of the elderly to southern states has slowed somewhat. Given the sluggish economy and

troubles with Social Security and pension funds, middle-class Americans tend to retire where they last worked. This has reduced demands on urban water systems and the environment in the South and Southwest. Meanwhile, the affluent have for many years been dispersing to rural areas all around the country, driven by the continued decline of resource-strapped urban areas and enabled by the communications revolution to work where they choose. This shift has increased pressures on small-town systems and rural ground-water supplies, and left some urban and suburban systems without the customers most able to pay for system improvements.

Where increased efficiency cannot meet growing demands, curtailment of water services and rationing of supplies has become more frequent. The public grumbles but largely puts up with these restrictions because the alternatives hit their pocketbooks too hard. Hookup fees for new development in all parts of the country are very high; utilities use high fees to discourage new demand on their systems and to help cover the costs of new capacity where they must expand. As a result, developers attempt to minimize their reliance on existing utilities as much as possible. They often use water-recycling systems and a strong emphasis on water efficiency to maximize their supplies, and they install advanced small-scale water-treatment systems to minimize their demands and reliance on utility treatment plants. As mandated by federal legislation passed in the early '00s, most new developments must include dual-pipe systems to deliver raw or reclaimed water for toilet flushing and outdoor uses, and treated water for washing and potable needs.

For the few utilities that are planning new infrastructure, capital is expensive and difficult to obtain. In recent years, a few water utilities that invested heavily in expanding service areas and treatment capacity went bankrupt when anticipated growth never materialized. These bankruptcies and general public resistance to rate increases have made investors more cautious about financing water infrastructure, especially when higher returns are available in global capital markets. Some communities, notably smaller ones and those that aren't growing, have had considerable trouble selling bonds due to their poor financial ratings. Federal and state governments encourage small utilities to consolidate in order to improve their chances of obtaining private funding and to share the limited resources they already have.

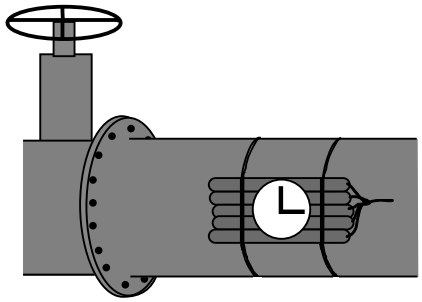
Excellent technologies for advanced treatment of drinking water are available, but few new plants are being built. Upgrades to wastewater plants are rare. To balance peak loads at wastewater plants that are operating above design capacity, some utilities have turned to holding ponds with artificial wetlands as a relatively low-cost way to defer expansion. What few resources utilities can pull together are spent on maintenance of distribution and collection lines in order to reduce water losses or sewer line infiltration that might contribute to a need for treatment capacity expansion.

Water managers suffer headaches and heartaches trying to comply with federal laws. Many simply cannot meet the requirements. At the same time, federal agencies are now so underfunded and understaffed that verification of compliance is low and enforcement is rare. Outbreaks of various pathogens in drinking water are noted frequently in the press, and studies show that the quality of the nation's surface waters has not improved much since the 1990s, and in some areas has fallen. The baby boomers cry foul, but won't open their pocketbooks for tax increases to fund enforcement and compliance assistance programs, nor rate increases to fund new infrastructure. Governments and most utilities can do little of substance to address the problems—or to meet the lofty goals of the nation's water laws.

In the midst of the angst, some utilities have done well. Their strategy: a long-term effort to educate the public about the technological requirements and costs of providing clean water. These utilities have substantial staff expertise in social science, education, and communication, and crusading managers who see their main role as informing and working with the public. Other utilities are now playing catch-up and hoping for similar success.

Approaching Apocalypse

Reduced Federal Role
Weak Financial Environment



Times are tight in 2010, and activist federal agencies are history. Federal financial assistance for water and wastewater infrastructure is unavailable. Many powers—including standard-setting and enforcement authority for drinking-water quality and wastewater discharges—have devolved to the states. But most state and local budgets are also strapped. Despite public concern over the safety of drinking-water supplies, the majority of ratepayers resist the higher bills necessary to finance needed infrastructure improvements.

The Best of Times, the Worst of Times

It all seemed so clear in the mid- and late 1990s. In 1996, echoing themes of the 1994 election, politicians who pledged to decrease the size and activism of government consolidated power. The public had spoken: get government off our backs. Congress slashed regulatory burdens on the private sector and lower levels of government. Authority for setting and enforcing water standards further devolved to the states. A host of federal grant and loan programs, including those for water infrastructure, were axed in an effort to reduce federal spending further and to pay for tax cuts. Many federal water projects were sold to the states and some to the private sector as part of a strategy to reduce the federal deficit. It all seemed to work; economic growth accelerated through 1999. The new century seemed certain to bring prosperous times.

Perhaps the growth was too fast and recession was inevitable. Perhaps by cutting regulations too far, the externalities of less fettered economic activity became too heavy a weight on the economy. At any rate, as the century turned it became clear that the federal government's fiscal house still was not in order. Eager to cut taxes but unwilling to cut defense and unable to slow skyrocketing health care costs, national leaders had made little progress on the federal deficit. When the deep, multi-year recession of the early '00s hit, tax receipts declined precipitously and the deficit ballooned to unprecedented heights. Capital markets tightened and interest rates soared. State and local governments were hit hard, too: already pressed by the burdens of making up for federal budget cuts, and now burdened with crisis management of once-federal water works, many had no choice but to raise taxes and cut programs dramatically to balance their budgets. Pinched by job losses, stagnation in wages, and tax increases, all but the most affluent citizens felt their wallets shrink.

After those tumultuous years, political control of the federal government and many state governments swung back and forth between the two main parties. Each courted the new parties that were gaining significant portions of the vote, but inter-party alliances shifted frequently. No clear public agenda emerged and the economy cycled repeatedly between recession and painfully slow growth. Financial pressures at all levels of government prevented public treasury support of water infrastructure. Water systems faced ever-stronger competition for capital from other resource-strapped public sectors. Some utilities, particularly in communities with declining tax bases and poor credit ratings, couldn't afford sufficient capital for needed improvements to water infrastructure; the worst-off systems cut costs with layoffs and continually deferred maintenance.

What's in Our Water?

The water news of the late '90s was not unlike the water news of the early '90s. Always eager for a sensational headline, the media played up every instance of water-supply contamination. Cryptosporidium-induced illnesses continued to grab attention, as did other pathogens turning up in water supplies. "Boil" orders became an all-too-frequent embarrassment to the drinking-water industry.

Reporters and water-industry critics increasingly linked these problems to the more relaxed regulatory environment. Some blamed weakened drinking-water treatment standards. Environmentalists claimed that without federal and state leadership, many watersheds were becoming increasingly degraded by development, logging, poorly regulated agricultural operations, and other activities, resulting in water-supply contamination. Failure to upgrade wastewater treatment systems was another frequently cited problem.

As the difficult first decade of the new century wore on, many drinking-water and wastewater utilities had no choice but to defer a growing list of system maintenance needs. In more affluent communities, ratepayers supported maintenance and improvement of existing systems. But in many less well-off areas, improvements to drinking-water plants became impossible. Limited funds were allocated instead to fixing the worst sections of aging distribution infrastructure, in order to reduce fire-fighting water pressure losses. Wastewater infrastructure also continued to decline in many areas, exacerbating concerns about the entry of pathogens into the nation's water supplies. Many systems refused new hookups, so developers responded by building and operating their own treatment systems—sometimes well and sometimes poorly, depending on the powers and capacities of state regulators.

In 2007, public concerns exploded as cholera—pandemic in Latin American for over a decade—jumped to the United States and spread sporadically through small, unmonitored rural systems, cross-connected lines in neglected inner-city neighborhoods, and even a few suburban systems where poorly supervised repairs to supply pipes allowed entry from leaky sewers. Aging, health-conscious baby boomers, AIDS patients, and other immuno-compromised populations grew increasingly distrustful of the promises of officials that "their" water supplies were safe. Some affluent communities opted to develop their own small treatment plants and broke away from financially troubled regional authorities, further weakening those systems. Even in well-maintained systems, the public was not quiet: alarms over treatment byproducts rose to a deafening volume.

Trouble on Water Street

Water supply managers in 2010 are in a tough spot. For many, long-range planning and investments have been replaced by crisis and chaos. As major sections of infrastructure fail, consumers face increasingly frequent "dry-outs" and bills that reflect expensive emergency repairs. Broken mains have flooded underground parking lots and below-grade offices in some cities, causing millions of dollars in damages. In some cities, water supplies are shut off regularly in the middle of the night to allow crews to make long-overdue repairs.

Relations with the public are difficult, even hostile. Many water utility officials, once accustomed to serving the public with relative ease and in relative obscurity, now feel pinched between public anger and fiscal impossibilities. Increasingly they find themselves on the front pages: lawsuits against water supply systems for failing to protect the public health have been filed in a number of cities. Some of the ablest managers are leaving the water sector for jobs in other fields.

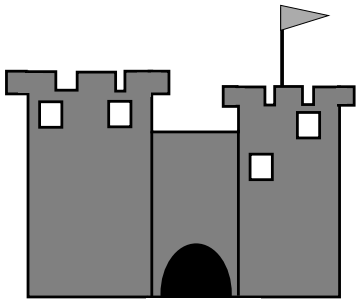
Given the public's lack of confidence in water supply utilities, entrepreneurship in alternative potable water supplies far exceeds 1990s levels. The bottled-water industry is booming. New, low-maintenance home water-treatment technologies are now available. These self-cleaning systems have moved the focus of home treatment from faucet to basement. Systems combining filters and low-energy ultraviolet treatment have found a huge market in the United States by making in-home assurance of the biological purity of all a household's water reliable and affordable for many families. Where taste, odor, and chemical contamination are a consideration, activated carbon add-ons are popular. Large portions of the public are installing home systems, apparently deciding that water purity is too important to leave to financially troubled and understaffed utilities. Unfortunately, the costs of home treatment are too high for many poor families. They continue to suffer from the water crisis expanding around them.

Household water demand is increasing as the number of home treatment installations grows, due to the extra water required by reverse osmosis and self-cleaning systems. Some supply utilities face looming water-quantity shortfalls as well as water-quality headaches.

As consumers lose faith in water utilities and take water purification into their own hands, ratepayer support for expensive upgrades and even some major maintenance to centralized drinking-water treatment plants dwindles further. Unable to finance improvements, some utilities strike innovative deals with state water regulators. These utilities provide customers with home treatment systems and then supply essentially raw water, rather than paying to replace decaying central treatment plants with expensive new ones. Inner-city self-help groups have been leaders in pushing such changes. As their constituencies have been hit hardest by the decay of centralized treatment systems, they have taken matters into their own hands and pressed for alternatives.

Seeking Camelot

Dominant Federal Role
Supportive Financial Environment



The public of 2010 demands a very strong federal role in addressing water-quality and water-quantity concerns. The EPA and other federal agencies set high standards, enforce them strictly, and are intimately involved in water-quantity management across the country. A strong economy, ratepayer support, and some federal government grants, loans, and loan guarantees ease financing of water-system capacity expansions, major maintenance, and treatment system improvements.

A New Agenda in Washington

The political changes of the mid-1990s were short-lived. The era ended as the electorate tired of ideological battles and demanded pragmatic, bipartisan government; growing populations of elderly, immigrant, and underemployed Americans found their needs unaddressed; and a series of events outraged an environmentally conscious public. Spotlight problems included another large oil spill in Alaska, the extinction of several key endangered species (including a number of salmon stocks in the Pacific Northwest), and several consecutive record hot summers—accompanied by severe drought in some regions and record storm events in others—that raised public concern over the possibility of climate change. Also, in many parts of the country, aquifer degradation loomed large. Toxics in ground water, contamination by faulty septic systems in booming rural areas, the decline of water tables, sea-water intrusion—all contributed to growing public consciousness that the nation's water resources required more careful and coordinated management. By the mid '00s, the environment had become a central and enduring political issue. Politicians of all stripes claimed environmental credentials, and several Green Party politicians were elected to Congress in the first decade of the new century.

As politicians who favored a strong federal government regained control, some social and environmental programs were reauthorized or re-engineered, and the EPA was elevated to cabinet status. Water-related environmental programs became especially popular with the public. The federal government was able to appropriate the funds necessary for a more activist approach to water resource management in part because the economy was generally strong; global politics were largely stable, allowing for cuts in defense; and strong bipartisan leadership tackled the skyrocketing cost of health care and other problems that once threatened to balloon the federal deficit and capture an ever-increasing portion of the federal budget.

Federal Activism and Regional Coordination

Recognizing the desire of an aging population for high-quality water and the importance of sound water-quantity management in an age of climate change, the federal government has by 2010 extended or established a variety of water-resources programs. Federal water-quality standards were strengthened early in the '00s. States, individual water systems, and consumers have come to expect and rely on strong federal enforcement of those standards. Federal grant, loan, and loan-guarantee programs for both water and wastewater treatment plants and distribution/collection lines are available to help some utilities meet the standards. Some of these programs are available to small private utilities that would otherwise have difficulty raising funds.

Unfortunately, some of the bureaucracy involved is slow and burdensome, leaving some utility projects on hold for years. Also, as in the 1990s, there are complaints over expensive, one-size-fits-all regulatory requirements, especially in their application to small utilities. Many smaller systems find the only way to keep up is to establish fairly long-term contracts with private firms that specialize in the testing and paperwork required by federal regulations. Ratepayers in such systems are unhappy with their skyrocketing water and sewer rates.

The federal government plays a central role in water-quantity matters as well. It continues to manage hundreds of dams, locks, irrigation systems and other water projects across the country. Federal agencies monitor surface-water quantity/quality relationships, and assert federal quality standards to assure adequate flows to protect environmental values. Because of wetlands regulations, protection of habitat for endangered species, and other federal environmental programs, large amounts of water essentially have been placed off-limits to development. Federal agencies also aggressively assert their reserved rights for instream flows, and assist Native American tribes in protecting their rights, which have expanded significantly over recent decades.

The federal role is also partly a coordinating one. The EPA's Environmental Resource Assessment Service (ERAS) is responsible for all federal environmental data and for coordinating federal data activities with state and local agencies. Among other things, ERAS satellites measure snowpack, soil moisture, and other water-supply variables. This information is integrated with data from localized, automated, on-ground weather stations, surface-water gauging stations, and ground-

water monitors (all under varied ownership but linked into one common data-gathering system). Federal computers integrate all this information and feed it to computers at individual water utilities and agricultural water districts that use the information to fine-tune local water management. Generally this system is well-liked, but the costs of the federal computers "going down" on a few occasions have been quite large due to the number of users served.

Beginning in 2008, multi-governmental regional water-allocation agencies were established in each of the nation's major hydrologic regions. Several of these new entities grew out of 20th-century interstate water compacts and river basin commissions. These agencies facilitate the resolution of large-scale water conflicts resulting from growth and climatic uncertainties. They have begun to serve as rudimentary sub-national land-use planning agencies. By setting clearer limits to water resource development, they have helped steer growth away from the most water-short areas. However, some citizens see the new agencies as another layer of insensitive and inefficient bureaucracy. Whether they can maintain public support in the long run is not clear.

New surface-water diversions are mostly ruled out by environmental concerns, so new municipal water supplies in water-short regions come largely from purchases of agricultural water, and also from increased efficiency and water reuse (including residential graywater systems). Interstate water markets are active, but they are closely supervised by the regional agencies, in conjunction with state water-rights engineers, to ensure protection of natural areas and minimization or mitigation of third-party and area-of-origin impacts. Areas relying on ground water place a high emphasis on efficiency and protection against contamination: in many states and localities, strict regulations on water use, agricultural operations, toxics, etc. supplement already strong federal regulations.

The Local Waterscape

At the local level, the public's desire for high-quality drinking water and a clean environment has continued to increase. Realizing that clean water is not cheap, ratepayers in most areas support increased rates for massive investments in infrastructure maintenance and treatment improvements. This and the consistent regulatory environment and healthy economy contribute to supportive capital markets. Federal assistance also helps many communities obtain capital, provided they meet federal requirements for water-efficiency measures and integrated resources planning.

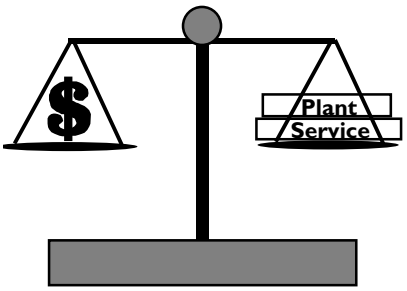
New filtering technologies greatly improve water quality and reduce organic content before disinfection at centralized treatment facilities. Because of strong regulation of treatment byproducts, no new systems relying on chlorination have been built in years. Old systems are converted to ozone, reverse osmosis, granular activated carbon or other technologies whenever they need significant repairs. As a result of these developments, public confidence in the safety of municipal drinking water has been growing in the past decade. The bottled-water and home-treatment industries fill niche markets, but have not expanded significantly since the late 1990s.

Utilities are investing heavily in information systems to allow greater monitoring of quality and greater control over water use. Irrigation of large municipal and commercial landscapes, golf courses, etc.—frequently using reclaimed water—is remotely dispatched by utility computers. In some areas water utilities make use of the fiber optic networks installed by communications companies. Like many energy utilities, they use these networks to monitor business and home resource use and charge time-of-use rates to encourage efficiency and maximize infrastructure capacity. Many water utilities are also sharing management operations to take the best advantage of new system-control technologies and the information-coordinating efficiencies provided by the Environmental Resource Assessment Service.

Despite many improvements in drinking-water quality and in the environment, critics point to flagrant wastes of taxpayer dollars on research and development of high-tech, centralized technologies to solve water-management problems. The federal desalination program established in the early '00s is a frequent target of such criticisms. Environmentalists complain that the federal government should do more to encourage the efficient use of water in homes and businesses. The holy grail of "rational" water management remains elusive.

Off to Market

Reduced Federal Role
Supportive Financial Environment



In this scenario, the federal government's role in regulating water in 2010 is minimal. So too is federal funding for water infrastructure. Federal water programs are largely oriented toward partnerships with lower levels of government and the private sector. Consolidation, privatization, and support from investors and affluent ratepayers enable some water utilities to finance needed infrastructure improvements, but others find the market-oriented times difficult.

Changing Creeds

The late 1990s and early '00s were a time of great change in the role of the federal government in American life. A number of agencies were eliminated, and the missions of others were reconceived and redirected. Of particular interest to water managers were the changes that resulted as savvy fiscal conservatives drew on the ideas of market-oriented environmentalists. These politicians had great success pushing private initiative and public/private partnerships for resource efficiency and pollution prevention as effective alternatives to command-and-control environmental regulations. As a result, in the early '00s the EPA was reorganized as the EEPA—the Economic and Environmental Proficiency Agency—to facilitate linkages between resource efficiency and private-sector profitability. The establishment and enforcement of water standards largely devolved to the states, in the belief that the site-specific, bottom-line benefits of resource efficiency and pollution prevention could most readily be achieved if regulatory activities were more localized.

Meanwhile, the market ethic of the day gave rise to a "pay-your-own-way" creed that led to cutting of many subsidies and internalization of many previously socialized costs. Highway funding gravitated toward higher state gas taxes and real-time, congestion-based, electronic toll systems. To cover increased demands for schools, public safety, and other public services, most communities imposed high impact fees on new development. User fees for a host of public assets and programs increased significantly. Many states did away with the tax exemption for public-purpose bonds.

The 21st-century public finally became convinced of what some economists had been saying for years: the private sector could run many municipal services more efficiently than public agencies. Privatization, in all its many forms, became the rage. Local governments sold off some assets. Public utilities and agencies increasingly contracted with private companies to run parts of their operations. Hundreds of public bodies altered procurement codes to facilitate more businesslike public-private transactions.

Entrepreneurs and innovative local governments developed a wide range of alternative financing mechanisms and public-private partnerships to meet water service needs. Private capital was attracted to the water sector by the strong support of affluent and middle-class ratepayers for increased water services—safe drinking water was a clear concern of the aging, health-conscious U.S. population. At the same time, private capital bypassed many poorer areas where declining infrastructure, vandalism, lawsuits resulting from poor water quality, and other problems increased perceived risks to investors.

Water States

In 2010, drinking-water standards are set and enforced by the states. They vary across the country, depending on the problems of particular regions. The flexibility in standards has helped control costs; no longer do water utilities complain of extra costs brought on by one-size-fits-all national standards.

In most states, regulation of wastewater discharges and surface-water quality is based on biological integrity goals rather than contaminant concentrations or best available technology. Local watershed councils, consisting of representatives from state agencies and local governments as well as private water users, are widespread. Some are even vested with regulatory powers aimed at protecting water supplies. The federal government joins many such efforts as a partner, rather than a lawgiver, providing information and coordinating across state lines. Besides no longer taking the lead on regulatory matters, the direct federal interest in water management is less than it was in the 20th century—much of the federal water infrastructure has been sold to the states and to the private sector.

The results of these developments have been mixed. Where public environmental concerns are strong, environmental goals are supported by local politicians and the agencies they oversee. Environmental health has improved significantly in these states. But in others, biological-integrity goals have been weakened by those who promote their states as more friendly to industry. Moreover, in areas with ailing economies, large low-income populations, or poor utility credit ratings, water-system improvements are difficult if not impossible to finance. Some systems have experienced a vicious downward spiral: rejection by private capital markets, leading to further deterioration in water quality and level of service, making finance of now desperately needed improvements all the more difficult. In certain

cases, the only solution has been the sale of systems to the private sector for a fraction of their value.

Many smaller utilities, public and private, are consolidating to achieve economies in management, economies of scale in plant and operations, and sufficient size to attract private capital. But many small-town systems are simply located too far from other systems for this. With limited financing options, and marginally regulated in some states, many of these systems are in steep decline.

In the absence of consistent national standards, public-health advocates claim that some state drinking-water programs are not comprehensive or tough enough. Lawsuits to force changes are increasing. Where wastewater standards appear lax, environmental groups, as well as municipal and industrial water users seeking to protect their water sources, are quick to sue for damages against polluters. In some pro-industry states this legal recourse is closed by laws limiting liability, so activists instead lead frequent public demonstrations against polluting facilities.

Demands Supplied

Consumer demand for water has moved in two directions in recent years. Among the wealthy, consumption is higher than ever due to more swimming pools, Jacuzzis, four-headed showers, indoor waterfalls, outdoor humidifiers, and other water amenities. This increase in use is especially prevalent in dry Southern states, where hundreds of thousands of wealthy baby-boom retirees have moved and taken up the "oasis in the desert" life-style pioneered by their parents and grandparents.

Meanwhile, utilities in less affluent areas, facing years of deferred maintenance and unable to raise funds in capital markets, have attempted dramatic rate increases to finance improvements internally. Consumer protests are increasing, and per-capita consumption is decreasing in the face of these higher rates. Utilities that inadequately estimated elasticity impacts face the unpleasant prospect of needing to raise rates even further.

The net effect has been an exacerbation of late-20th century trends. In many parts of the North, water is available, but a static or declining customer base cannot support rapid improvements in quality-related infrastructure. In the South and West, growth helps finance water-quality improvements, but water supply is a continuing challenge.

In the arid West, water is now seen as an economic commodity that can be allocated most efficiently by market mechanisms. Water purchases and leases are a very common municipal supply initiative. Ever since agricultural subsidies were eliminated, substantial quantities of water have been offered in water markets.

Where water cannot be purchased and wheeled to municipal supply lines, increasing water-use efficiency is a high priority. In such areas, water reuse, including direct potable reuse, accounts for a significant portion of the water supply. Many utilities rely on the real estate development sector to drive efficiency improvements. These utilities hold that developers must pay most or all of the marginal cost of new water supplies and treatment capacity, or the developers must buy supplies and treatment capacity from existing water users by retrofitting homes and businesses with graywater systems, rainwater collection systems, and more efficient fixtures, appliances, landscapes, and irrigation systems.

Taking a cue from successful efforts in the electric-utility industry to develop distributed, small-scale power generation capacity focused on renewables, water utilities and developers increasingly meet new treatment needs with small-scale systems located closer to end-users. The incrementalism and resiliency (not all eggs in one central basket) of new, modular drinking-water purification systems and of small wetland and other biological wastewater-treatment systems match well with the "move fast, stay flexible" ethic of the market society. One indication of the changes in utility structure is that upper management at most water and wastewater utilities is now dominated by MBAs rather than engineers.

Free-market advocates cheer the economic efficiency of the new regime, but not everyone is so happy. Where water purchases, efficiency efforts, and reuse are not keeping pace with growth, new water projects are being built, much to the chagrin of environmentalists. In the market ethos of the times, "public goods" such as instream flows must compete against other resource uses, and rarely outbid them. And in the agricultural sector, family farming areas have been hit hard as struggling operations sell their water rights.

Scenarios are useful to planners, managers, citizens, and public policy makers in two ways. First, they can inspire a *process*: a disciplined approach toward examination of the future that can have enormous value for those who undertake it. Second, they serve as a tool, a *product*, that can spur creative thinking, raise questions, and reveal important implications about decisions and strategies.

The Process: Scenario Building

The process of building scenarios is itself of enormous value, often dramatically changing participants' perspectives about the future. Practitioners of scenario building widely agree that the exercise, properly conducted, influences decisions and strategies more than the narratives alone.

Scenario building is way of thinking, a technique for gathering insight about the future. The results are usually most interesting when people with a broad range of expertise and experience are involved. Ideally, a team of people should be brought together face-to-face to brainstorm lists of driving forces, collectively evaluate those forces, toss around ideas about potential interactions between the various factors, and construct preliminary scenario plots. A group of 10 to 15 is considered a good number for a scenario workshop, though more may be included through various group-process tools and public-involvement strategies. Once the larger group has outlined ideas for scenarios, a small number of participants can then huddle to write the actual scenarios.

We hope this report will inspire scenario-building efforts by individual water systems, local governments, state and federal agencies, water-industry associations, and other organizations involved in the management of the nation's water resources. The development of scenarios focused on specific strategic decisions facing a particular organization or a sector of the water industry will highlight special risks and opportunities for that organization or sector. As such efforts get under way, the scenarios presented in this report offer one possible starting point for discussion. Steps for preparing scenarios are described in the appendix.

The Product: Scenarios

Scenarios are a springboard to critical reflection about the future. They can challenge one's preconceptions about the future—a good thing, since in these fast-changing times the future is hardly ever "business as usual." Scenarios are especially good for revealing how the larger forces playing out around an organization, both within and beyond a particular industry or sector, may affect the interests of the organization and determine what is possible for the organization, and what is necessary for it to thrive.

Examining scenarios can illuminate the risks and opportunities presented by specific decisions and strategies for the future. Scenarios can help in determining whether a particular strategy is robust—that is, whether it holds up in a variety of different futures. They also help make explicit the assumptions that must be made if one is banking on a particular future coming to pass—in other words, scenarios not only describe what plausibly could happen, they also reveal what plausibly *must* happen for various futures to develop. Then the question is this: if your decisions rely on one future coming to pass, how confident are you that the developments required to get there will actually occur?

The scenarios in this report were designed to touch on a wide range of concerns facing water systems today—concerns relevant to the strategic-planning efforts of water utilities and environmental and public-health agencies. Four very different futures are portrayed. The implications that can be drawn from them are many. Each reader will likely approach these scenarios with different issues and decisions in mind, and will take away different lessons. As a starting point for reflection, we suggest the following questions relevant to each scenario:

Mandate—Some would say this scenario is not so different from where we are today: tough federal requirements, and inadequate resources to meet them. Will public demands for safe water and a clean environment combine with the budget battles occurring at all levels of government to intensify this situation? If so, what will state regulators and local

water-system managers do? If requirements on water systems are reduced, does the municipal water sector follow the path outlined in one of the two scenarios with a lessened federal role? Or does something else happen?

Approaching Apocalypse—This scenario is so bleak, from the point of view of most consumers, water utilities, and government agencies, that it is tempting to dismiss it as highly unlikely. But are we so sure? What might a combination of deep trouble in the general economy and long-deferred maintenance and improvement of water systems bring?

Seeking Camelot—If the federal government is to continue or increase its lead role in water management, are various crises necessary preconditions? What else might be required? Control of the federal deficit? Stable geopolitics? Are these good bets? How might increased federal government activism affect capital markets for water projects, and constrain or support local water management?

Off to Market—Will the political changes set in motion by the 1994 election continue, and how might they be manifested in the water sector? Can environmental and public-health goals be reconciled with a more liberalized market economy? How so? What about the distribution of wealth and of water services? Who wins and who loses?

Our scenarios raise these and other questions. They are offered as thought pieces, not as answers. We hope they will engender reflection and discussion that suggests appropriate strategies to address uncertainty and change. Ultimately, if these scenarios provoke vigorous dialogue and challenge assumptions about the future, they will have done their job.

Appendix: The Scenario-Building Process

Scenario building involves a number of steps; a generic process is presented here.[7] In addition, this appendix discusses how the authors approached and modified the general methodology for this specific project.

While the process is presented here as a series of discrete steps, in practice it is more iterative and creative than linear and mechanical. As ideas are generated and facts and judgments checked, scenario builders often go back and forth between and within the steps discussed below. Moreover, scenarios are best built by teams; the perspectives and creativity of multiple individuals tend to result in scenarios that are simultaneously more surprising, more plausible, and richer in contextual detail. Also, when scenarios are being built for a particular organization, the results are most likely to affect decision-making if the group includes some top managers.

Rocky Mountain Institute assembled a peer-review team of three dozen experts in various aspects of municipal water systems and water resources generally. These individuals provided information and feedback at various stages in the scenario-building process. Their names and affiliations are provided in the acknowledgments section of the report.

Identify Audiences, Focal Issues, and Key Decisions

Scenarios are usually oriented toward a particular organization or a well-defined audience. Focusing on an adequately limited audience allows development of the contextual richness necessary for the reader or listener to identify and connect with the situations envisioned in a set of scenarios.

Likewise, scenario builders must have in mind a set of key issues and important decisions facing the chosen audience. What decisions are the scenarios meant to shed light on? Good scenarios can be useful in considering a wide range of decisions, but building scenarios around specific issues and decisions increases their impact.

In this project, Rocky Mountain Institute's charge was to develop scenarios of broad interest to individuals and organizations active in the municipal water sector. The primary audience was defined as persons most directly concerned with the performance of individual municipal and community water systems: water and wastewater utility (public or private) planners, managers, and board members; local government officials charged with oversight of water systems; and concerned citizens who lobby or advocate on rate, service, environmental, and other water-utility-related matters. A secondary audience included state and federal regulatory agency personnel. Other stakeholders concerned with municipal water services, considered but not chosen as focal audiences in this project, included legislators, judicial authorities, infrastructure contractors, water-technology manufacturers, plumbers, plumbing-supply retailers, developers, landscapers, and a variety of classes of individual water users.

The issues and decisions facing municipal water systems are many. Should a water or wastewater system, in the near or longer term, secure new raw water supplies, invest in new infrastructure, promote increased water-use efficiency, maintain or repair existing infrastructure, expand or limit its service area, consolidate with other water utilities, change its ownership status (privatize or become public), or expense or bond the cost of these or other actions? Rocky Mountain Institute focused particularly on issues in water supply, investment in infrastructure, and efficiency and alternative approaches to providing water services.

Identify Key Factors in the Local Environment

Understanding the nature of the audience and its decision-making processes is crucial to the development of good scenarios. A variety of "internal" factors help form the context for a scenario plot. For instance, what type of information is necessary for making decisions about a water system? Decision-makers must have information about quantities and qualities of water, revenues and expenses, water user needs, and other factors. How will success be defined? It may be defined by profitability, return on investment, improved predictability or manageability of the water system, good bond ratings, satisfied customers, positive (or no) media coverage, and a variety of other considerations. What internal factors affect decision-making and decision outcomes? Factors to consider include financial resources, creativity, leadership, accountability, predictability of the system, capital and labor productivity, the breadth and depth of the problem set faced, and the degree of collaboration between water-system managers, the public, and other stakeholders. All these factors are not so much the driving forces in scenarios; rather, they are parameters that determine which forces are most important to consider when building scenarios.

Uncovering and acknowledging internal factors is very important when building scenarios for a particular organization or focusing scenarios on a particular decision or strategic-planning issue. Given that Rocky Mountain Institute's task in this project was to develop scenarios of broad interest to a variety of organizations, specific internal factors were not identified and prioritized.

List Driving Forces

Scenario builders should brainstorm as broad a list as possible of forces that may influence how the world of the audience might look in the future. It is important at this point to involve people with wide-ranging perspectives, and not to censor any idea as too unimportant or implausible. Once a substantial list of potential driving forces has been compiled, categorizations and evaluations can begin.

In May of 1992, the Futures Studies Group of the Environmental Protection Agency held a two-day workshop on the future of municipal water services, with a special focus on the residential subsector.[8] Invitees came from federal, state, and tribal government agencies, national labs, water utilities, universities, non-profit think tanks and associations, consulting firms, and other organizations. Attendees split into four focus groups to consider current and anticipated developments in four areas: economics and financing, policies and institutions, social factors, and technology and resource management. They used a modified nominal group process to generate, categorize, and rank lists of potential driving forces in those areas. The workshop generated over 160 ideas for important forces that could drive the future of residential water services in the United States.

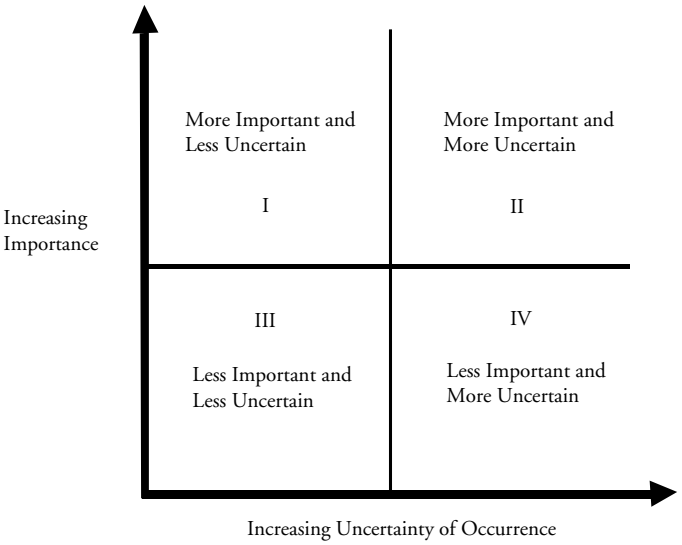
Rocky Mountain Institute used information from this workshop as a starting point for a list of potential driving forces. We pored over the workshop's 160-item list, removed vague statements and a large number of redundancies, combined related ideas into more comprehensive statements, and modified some statements to better reflect changes over the three intervening years and to reflect the purposes of the scenario-building project. We added a number of potential driving forces as well, and grouped the forces into six areas: management, finance/economics, policy/institutions, technology, environment, and society.

The result was a list of 70 potential driving forces, which was sent to members of the peer review team. The list was designed as a qualitative survey on which the reviewers could indicate their judgments of the importance and likelihood of occurrence of each factor, provide comments about each, and suggest any that had been missed. Besides providing valuable insights to the authors, many of the peer reviewers indicated that this exercise was thought-provoking and useful for their own purposes. One general manager of a water utility circulated copies of the survey among his organization's upper managers to encourage consideration of how those forces might impact the utility.

Rank Driving Forces by Importance and Uncertainty

Driving forces can be ranked according to the likelihood they will occur, and according to their importance if they do occur. They can then be mapped in a two-dimensional space, as shown below. One axis locates driving forces in terms of increasing importance, while a second axis locates them based on increasing uncertainty of occurrence. Four generalized quadrants, or categories, of driving forces can then be identified.

Those driving forces ranked as less important, regardless of their probability (quadrants III and IV), may influence the context of the eventual scenarios, but are not central to them. Many, especially those considered most uncertain, will not appear in the scenarios at all.



The forces judged more important and less uncertain (quadrant I) are often major elements of the scenarios. Because these important forces are fairly certain, they may be common to all the scenarios in a scenario set. They may be new but highly likely developments—for instance, some technological changes. They may also be "predetermined elements," such as the aging of infrastructure. In many water systems across the country, significant elements of the infrastructure are near or beyond their expected service life spans. They obviously get older with every year, and must be dealt with sooner or later.

Driving forces considered more important and more uncertain (quadrant II) are key to scenario sets. Typically, these factors form the basis for the variation between scenarios. Scenario builders often call these factors "critical uncertainties." As an example, consider the trend many analysts have identified toward the increasing treatment of water as a commodity in law, policy, and water-system management. Market-enabling policy reforms and trading of water rights in the Western United States have shown the import of this development. Should the Colorado River Compact be modified to allow interstate marketing of water—as some interests are increasingly pressing for—the trend and its impact will be accelerated. On the other hand, environmental regulations and the use of the public trust doctrine augur against increased commodification of water. The apparent movement toward commodification could play out in a variety of ways of enormous significance to the availability of new water supplies for municipal uses.

One way to identify critical uncertainties is to question assumptions about predetermined elements. What might make an assumption wrong? Scenario builders also identify critical uncertainties by asking of the factors listed in the brainstorming portion of the process, "What happens if this occurs?" and "How might this occur?" Some such evaluations of driving forces can be supported by data and literature reviews, but often the informed judgment of the scenario builders is of central importance.

Rocky Mountain Institute used the judgments and comments on the surveys returned by review committee members for qualitative analysis of the importance and uncertainty of driving forces. This information helped guide our selection of the factors that would appear most prominently in the scenarios.

Select Central Scenario Drivers and Scenario Plots

The previous step may identify several critical uncertainties. A small number of these must be chosen as the foci—the central drivers—of the scenarios. For each critical uncertainty chosen as a central driver, the scenario builders will assume a small number of outcomes. Combinations of these outcomes will determine the general nature of the scenarios.

We chose to use a political/institutional critical uncertainty and a financial/economic critical uncertainty as the central drivers for the scenarios. As explained earlier in this report, these drivers were: a) the federal role in water management, and b) capital availability and public willingness to support increasing costs for maintenance, improvement, and expansion of infrastructure. We believed the interplay of these two critical uncertainties would yield the most interesting scenarios of broad relevance to municipal water systems. By assuming two generalized directions for the future unfolding of each of these two drivers, we developed a matrix of four possible outcomes, as shown earlier in the report. This is a common method for establishing a framework for scenario development. We built the scenario stories around these four possible futures.

Scenario plots, or "logics," help make sense of the effect and outcome of central drivers unfolding in particular ways. They also help organize other driving forces and the internal factors relevant to the audience into meaningful and captivating narratives of possible futures.

A number of "standard" plots can be examined for their usefulness in organizing a scenario. "Winners and losers" is a common outcome of developments in the world around us. "Evolution" and "revolution" are well understood, and so too are plots with cyclical elements, such as "decay and rejuvenation." "Challenge and response," as sometimes portrayed in the quantitative or qualitative growth of a once-troubled institution, is another example of a way to make sense of the forces coming together in a potential scenario. Some plots work better than others for portraying the potential outcome of different forces; picking and developing the best plot is more art than science.

The scenarios developed in this project roughly follow several different plots. "Seeking Camelot" and "Mandate" essentially reveal an evolutionary logic to changes in the federal government role. "Off to Market" portrays fairly revolutionary change in government and finance. "Approaching Apocalypse" is a tale of decay—with rejuvenation remaining a dim prospect.

Flesh Out The Scenarios

The next step is to put meat on the bones of the plots. The objective is to develop narratives that plausibly illustrate what the world—that is, those aspects of the world relevant to the audience—could look like in the future. As noted above, the narratives should revolve around the unfolding of the central critical uncertainties. They usually include believable stories of how the world gets from the present to each envisioned future.

Important but less uncertain factors help add texture and richness to the scenarios. Characters and places, real or hypothetical, can help the reader identify with the stories being told. Fleshing out scenarios is much more an exercise in creative writing than a matter of documenting research findings.

The point of scenario building is to challenge assumptions and spark reflection. Good scenarios resonate with the current realities of the readers, then lead readers to consider the unfamiliar or uncomfortable. The premise of the "story-telling" method of scenario writing is that vivid, plausible narratives can often engage readers better than dry, highly analytical studies.

Initial drafts of the scenarios developed in this project were circulated to the review committee for comments. Feedback from the reviewers was incorporated to bolster the basic thrust of each scenario, correct obvious inconsistencies or inaccuracies, and add interest.

Consider Implications

Scenarios in hand, one can "rehearse the future." How does a particular decision or strategy perform in each future? How does another? When the people using the scenarios are the people who built them, the implications will usually be obvious. The process of building the scenarios will have drawn them out for the participants.

People using scenarios built by others must locate their own interests and issues in the stories offered. Broadly aimed scenarios, such as those presented in this report, challenge the reader to consider a host of developments, some of which may be relevant to the interests of the reader, and some not. But their usefulness also lies in this breadth—by touching on a wide range of issues and developments, they may engage the reader to consider factors that may have been "off the radar" before. The implications must be teased out by each reader, depending upon the particular issues he or she faces. Discussing the scenarios with others who face the same issues is one sure way to draw out useful ideas and implications. Scenarios prepared by others, then, can be a starting point in forming strategies for a world of change and surprise.

Notes

1 Peter Schwartz, *The Art of the Long View* (New York: Doubleday Currency, 1991), pp. 3-4.

2 *1992 Needs Survey Report to Congress: Assessment of Needs for Publicly-Owned Wastewater Treatment Facilities, Correction of Combined Sewer Overflows, and Management of Storm Water And Nonpoint Source Pollution in the United States* (Washington, D.C.: U.S. Environmental Protection Agency, report EPA/832/R-93-002, 1993).

3 Wade Miller Associates, *Meeting the Management, Organizational, and Staffing Challenges of the 1990s* (Denver: American Water Works Association Research Foundation, 1993), p. 11.

4 Some lobbyists and politicians focus considerable attention on SDWA-related costs, but these may be only a small portion of the total capital requirements for the drinking water industry. Some studies estimate direct SDWA costs of about $20 billion over the next 20 years, or about 12–15% of the total estimated needs. Janice Beecher, Patrick Mann, and John Stanford, *Meeting Water Utility Revenue Requirements: Financing and Ratemaking Alternatives* (Columbus, Ohio: The National Regulatory Research Institute, 1993), pp. 9-10.

5 Gregory J. Kirmeyer, William Richards, and Charlotte Dery Smith, *An Assessment of Water Distribution Systems and Associated Research Needs* (Denver: American Water Works Association Research Foundation, 1994), p. xv. This report estimates that 29% of the distribution pipe nationwide is in only "fair" or "poor" condition. Some older systems have a much higher proportion of potentially problematic pipe. New pipe installed today has an expected service life of 50 to 100 years (pp. xiv-xv).

6 See, for instance, Edward J. Amatetti, *Meeting Future Financing Needs of Water Utilities* (Denver: American Water Works Association Research Foundation, 1993), pp. 4-9.

7 This discussion of methodology follows an outline presented by Peter Schwartz in *The Art of the Long View* (New York: Doubleday Currency, 1991), pp. 226-234.

8 U.S. Environmental Protection Agency Futures Studies Group, "The Future of Residential Water Services and the Environment, Focus Group Reports" (Washington, D.C.: U.S. Environmental Protection Agency, Office of Strategic Planning and Environmental Data, 1992).

Acknowledgments

This report was prepared under a Cooperative Agreement with the Environmental Futures Group of the U.S. Environmental Protection Agency. We are also grateful to the New-Land Foundation, The William and Flora Hewlett Foundation, and The Joyce Mertz-Gilmore Foundation for support of Rocky Mountain Institute's Water Program.

The authors appreciate the assistance of Joseph Abe and Michael Colby, formerly of the Environmental Protection Agency's Futures Group. Jim Dyer, past director of the Water Program at Rocky Mountain Institute, provided much of the initial direction and management for this project. Additional Rocky Mountain Institute staff who assisted with this project include Owen Bailey, Michael Brylawski, David Cramer, JoAnn Glassier, Ross Jacobs, Amory Lovins, Hunter Lovins, Kate Mink, Jannea Moore, Dave Reed, Louie Saletan, and AJ Thompson.

The following individuals volunteered their time as peer reviewers for this project:

Joseph Abe	Business Ecology Network
Marilyn Arnold	Pequod Associates
Janice Beecher	Indiana University, Center for Urban Policy and the Environment
Peter Censky	Water Quality Association
Mike Colby	U.S. Environmental Protection Agency, Futures Group
Kathryn Corry	Denver Water
Claudia Cummins	RBD, Inc. Engineering Consultants
Jim Dyer	Independent Consultant
Stephen Estes-Smargiassi	Massachusetts Water Resources Agency
Larry Farwell	California Department of Water Resources
Liz Gardener	Denver Water
Rick Giardina	Rick Giardina and Associates
Peter Gleick	Pacific Institute for Studies in Development, Environment, and Security
George Gray	U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assistance
Barbara Harmony	The Water Center
Mike Horner	National Association of Water Companies
Penny Howard	U.S. Bureau of Reclamation, Mid-Pacific Region
Ric Jensen	Texas Water Resources Institute, Technology Transfer Office
Lee H. Johnson	Carlson, Hammond, and Paddock
Andrew Jones	Independent Consultant
Ken Kirk	Association of Metropolitan Sewage Agencies
Christine Koppel	Water Environment Federation
Ronald Lehr	Denver Water
Larry MacDonnell	Sustainability Initiatives
L.D. McMullen	Des Moines Water Works
Jonas Minton	Sacramento Area Water Forum
Erik Olson	Natural Resources Defense Council
Sandra Postel	Global Water Policy Project
Martin Reuss	U.S. Army Corps of Engineers, Office of History
Lorna Stickel	Portland Water Bureau
John Todd	Ocean Arks International
Diane VanDe Hei	Association of Metropolitan Water Agencies
Amy Vickers	Amy Vickers & Associates
Sam Wade	National Rural Water Association
Kenneth Wentink	American Society of Plumbing Engineers
Bob Wilkinson	Independent Consultant

We also received assistance from H.J. Barry, John Davidson, Marilyn Katz, Steve Keach, Jack McGregor, James McInerney, Margaret Saxton, Ron Stanley, and William Werick.

We are very grateful to all these colleagues for their time and their insights. Although the work described in this report has been funded in part by the United States Environmental Protection Agency through Cooperative Agreement X819188-01-1 to Rocky Mountain Institute, it has not been subjected to the Agency's required peer and policy review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred. In no way does the listing of any other individual or organization above imply their endorsement of the final scenarios and overall report.

About Rocky Mountain Institute

Rocky Mountain Institute is a nonprofit research and educational foundation with a vision across boundaries. Seeking ideas that transcend ideology, and harnessing the problem-solving power of free-market economics, our goal is to foster the efficient and sustainable use of resources as a path to global security. The Institute addresses problems and solutions in the areas of energy, water, agriculture, security, community economic development, transportation, and environmentally responsive real estate development.

Rocky Mountain Institute's work in the water field takes three forms: research into innovative techniques for water resources planning and implementation of water efficiency programs; outreach to the water industry and consumers through publications and referrals; and consulting to water utilities, government agencies, and others. Our water staff have gathered information on emerging water-efficient technologies, written case studies of effective conservation programs, evaluated water system plans and water efficiency options, prepared scenarios, and guided efforts to develop computer models for water resources management.

1739 Snowmass Creek Road
Snowmass, CO 81654-9199
970/927-3851 FAX 970/927-4178
http://www.rmi.org

Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, Colorado 81654-9199
970/927-3851 FAX 970/927-4178
Website: http://www.rmi.org